V. *Discussion of the Observed Deviations of the Compass in several Ships, Wood-built and Iron-built: with a General Table for facilitating the examination of Compass-Deviations.* *By* G. B. Airy, *Esq., Astronomer Royal.*

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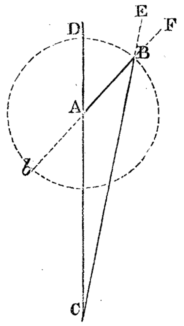
In the year 1839 I communicated to the Royal Society a paper (printed in the Philosophical Transactions of that year) containing the results of examination of the compass in two iron-built ships, and a general theory of the effect of the transient induced magnetism of iron in disturbing the direction of the compass-needle. The result of the theory of induced magnetism may be stated as follows.

First, I must premise, in explanation of the term "polar-magnet-deviation" which I shall frequently have occasion to use, the following theorem on the disturbance of the compass by a magnetized steel bar, or one which possesses independent polar magnetism, in no way referred to the influence of the existing terrestrial magnetism. Let the line CA, fig. 1, represent in magnitude and in direction the terrestrial directive force. [In the applications of the theory to ships, the terrestrial directive force is diminished in a constant ratio differing little from unity; and then it must be understood that CA represents the terrestrial force so diminished.] A is understood to be the magnetic-north end of the line. And let AB represent, in proportional magnitude and in direction, the directive force of the magnetized steel bar or "polar-magnet," B corresponding to that end of the polar-magnet which possesses boreal magnetism. Then the directive force which really acts on the compass-needle will be represented in proportional magnitude and direction by CB; and the angle ACB will be the angle of deviation of the compass. And if the polar-magnet be turned round in azimuth, so that the point B occupies successively different points in the circumference of the circle, the angle of deviation will have successively the different magnitudes and the different directions (right or left of the line CA) given by this construction for these different circumstances. This theorem is very simply founded on the ordinary "composition of forces," and is abundantly proved by experiment. The deviation ACB is what I shall call "polar-magnet-deviation." In some cases it is convenient to refer the azimuth of the polar-magnet to the *true* magnetic meridian or CA, and then the polar-magnet-deviation is given by this formula:

Fig, 1.



$$\tan \text{ACB} = \frac{\text{AB} . \sin \text{BAD}}{\text{CA} + \text{AB} . \cos \text{BAD}},$$

where BAD is the *true* azimuth of the polar-magnet. In other cases it is convenient to refer the azimuth of the polar-magnet to the *disturbed* direction of the compass-needle or BE, and then the polar-magnet-deviation is given by this formula:

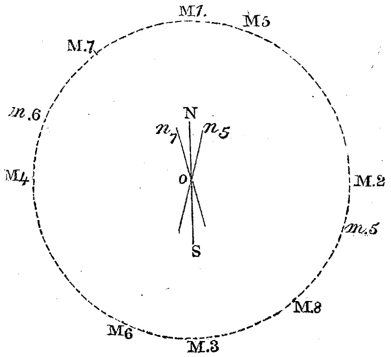
$$\sin \text{ACB} = \frac{\text{AB}}{\text{CA}} \cdot \sin \text{EBF},$$

where EBF is the *apparent* azimuth of the polar-magnet. In either case, the law which connects the polar-magnet-deviation with the azimuth (true or apparent) of the polar-magnet is what I shall call "the law of polar-magnet-deviation."

Secondly: the disturbing effect of the polar-magnet, whose power is represented by AB, may be completely neutralized by attaching to the same frame (whether it be a ship, or an experimental wood frame, &c.) which carries that polar-magnet, another polar-magnet in the opposite position, its power and direction being represented by the line A*b*.

Thirdly: if, instead of the polar magnetism of a steel bar, the disturbing force upon the compass be that of the transient induced magnetism in a nearly spherical mass of soft iron possessing no permanent magnetism, placed in the same horizontal plane as the compass; and if NOS, fig. 2, represent the position taken by the needle under the action of terrestrial magnetism only; then if the mass of soft iron be in either of the positions M_1, M_2, M_3, M_4, it will not disturb the needle NOS: if the mass of soft iron be placed either in the quadrant between M_1 and M_2 (as at M_5) or in the quadrant between M_3 and M_4 (as at M_6), it will make the point N deviate towards n_5; and if the soft iron be placed in either of the remaining quadrants (as at M_7 or M_8) it will make the point N deviate towards n_7. The amount of deviation is proportional to the sine of double the angle of azimuth of the disturbing mass, that is to the sine of double the angle M_1OM_5, or M_1OM_8, &c. If the disturbing mass be carried round the circle in the direction $M_1M_2M_3M_4M_1$, the deviation of the needle (estimated positive when the point N is moved towards the right, and negative when towards the left) will in the four quadrants have the signs $+-+-$. The deviation following this law I shall call "quadrantal deviation."

Fig. 2.



Fourthly: the deviation produced by the mass of soft iron at M_5 will *not* be corrected by placing a similar mass at M_6 (which, instead of correcting the deviation, will double it), but it *will be* corrected by placing a similar mass either at m_5 or at m_6, the angles M_5Om_5 and M_5Om_6 being supposed to be right angles. Similarly, the deviation produced by the mass at M_6 will be neutralized by a similar mass either at m_5 or at m_6, if the angles M_6Om_5, M_6Om_6 are right angles. Thus the "quadrantal deviation" may be corrected by attaching to the same frame (whether it be a ship, or a wooden experimental frame, &c.), which carries the mass that produces the "quadrantal deviation," another mass, at the same level as the compass but in an

azimuth differing 90° from that of the disturbing mass. And, if it be found that when a ship's head is in the quadrant between N. and E., or between S. and W., the needle deviates to the right, and the opposite way for the remaining quadrants; or that, in respect to the quadrants of azimuth of ship's head, the quadrantal deviation follows the law $+-+-$ which I shall call "positive quadrantal deviation;" the inference is that the deviation is of the same kind as would be produced by a mass of iron at the same level as the compass, either headward or sternward of the compass: and it may be neutralized by placing a mass of iron at the same level as the compass, either on the starboard or on the port side. But if the deviation follow the law $-+-+$ in respect of the four quadrants of azimuth, which I shall call "negative quadrantal deviation," it may be neutralized by placing a mass of iron at the same level as the compass, either headward or sternward of the compass. All these laws I have abundantly confirmed by experiment.

These being premised, the laws of the deviation of the compass produced by the transient induced magnetism of a ship, as shown by swinging the ship round in a given locality, will (according to the theory to which I have referred) be as follows:—

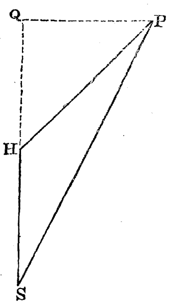
(1). There will be a force, similar to the force of a polar-magnet, and producing a polar-magnet-deviation. In northern magnetic latitudes, the nature of the effect will usually be the same as if the boreal magnetism were towards the ship's head: in southern magnetic latitudes, it will be usually the same as if the austral magnetism were towards the ship's head. The absolute magnitude of the polar-magnet-force will be a multiple of the vertical terrestrial magnetism; the proportion which it bears to the terrestrial directive force, which is the proportion of AB to AC in fig. 1 (supposing no other polar-magnet-force to act), will be a multiple of the tangent of dip, without regard to the absolute force.

(2). There will be a quadrantal deviation; and this deviation will be the same in all magnetic latitudes, and whatever be the magnitude of the earth's magnetic force. It will usually be a positive quadrantal deviation.

These are the disturbances that are produced by transient induced magnetism only. But if the iron that enters into the composition of a ship possess independent polar magnetism similar to that of a magnetized steel bar (*i. e.* not depending on the terrestrial magnetism at the present moment for its existence; and not changing its amount or quality or direction in regard to the ship's keel, while the ship is swung round in different positions), which from the slowness of its changes, though probably more variable than that of a steel bar, I propose to call "subpermanent magnetism;" it will be necessary for us to consider how the expression for the effects of this subpermanent magnetism can be most easily combined with those for the induced transient magnetism. It is readily seen that the polar-magnet-force of subpermanent magnetism must be combined with the polar-magnet-force of induced transient magnetism; and that, at a given locality, they cannot be separated. In

fig. 3, let SH represent the magnitude and direction of the polar-magnet-force of induced magnetism, directed from the ship's stern to her head (this diagram having no relation to the direction of terrestrial magnetism), and let HP represent the magnitude and direction of the subpermanent magnetism, which, inasmuch as its direction is invariable with respect to the ship, is inclined at a constant angle to SH: then the force resulting from the composition of these two will be represented in magnitude and direction by SP, which is invariable in magnitude, and inclined at a constant angle to SH. And this force will appear, in the phenomena of compass-disturbance at any one locality, as a whole, and cannot immediately be separated into the two parts SH and HP.

Fig. 3.



All that can be done is this. At a given locality we can find the direction of SP with regard to the ship's keel, if, by methods to be explained below, we can find the "neutral position of the ship in reference to the polar-magnet-force," or (which is the same thing) the azimuth of the ship's head, or of the line SH, when the polar-magnet-deviation vanishes, or when the line SP coincides with the magnetic meridian. And we can find the magnitude of SP by methods to be explained below. Therefore we can find SQ and QP. And if we assume HQ to be constant, and SH proportional to the earth's vertical magnetic force at the given locality, we shall be able, by comparison of the results at different localities where the vertical force has different magnitudes, to discover the value of SH at each place and the value of HQ. The value of QP however requires no combination of results found at different places, and is not liable to any uncertainty.

But without at present insisting on this separation of the subpermanent magnetism from the polar-magnet-force of induced magnetism, we can lay down the following rule:—

(3). The whole disturbance of the compass, whether the ship be wood-built or iron-built, will be represented by the sum of the effects of two forces, which separately would produce these two disturbances: one, a polar-magnet-deviation whose neutral point may be in any direction; the other, a quadrantal deviation, which may be expected to be a positive quadrantal deviation, following the law of signs $+-+-$ as depending on the quadrants of azimuth of the ship's head. And the whole disturbance will be very nearly (but not exactly) the algebraic sum of these two disturbances: the slight departure from that law will be the subject of examination below.

The practical problem, then, of analysing a given series of compass-deviations, is reduced to the dividing of them into two parts, of which one follows the law of polar-magnet-deviation, and the other follows the law of quadrantal deviation, subject to the trifling correction to which I have just alluded.

In the experiments with the 'Rainbow' and 'Ironsides' (which are treated in my

paper in the Philosophical Transactions, 1839), I was guided by experiments on horizontal intensity as determined by vibrations; but even then I found the computation of polar-magnet-deviation so troublesome, that I executed the calculations by graphical construction. But in other cases, where there is no determination of horizontal intensity, the computation of polar-magnet-deviation would be very much more troublesome. This consideration, together with the paucity of instances in which a comparison of the ship's magnetism in different localities was possible, prevented me from entering further into the numerical calculations of ships' magnetism. But having lately received from Captain WASHINGTON, R.N., Hydrographer to the Admiralty, the records of observations in several ships, which I desired to treat numerically; I remarked that the trouble of calculation might be much diminished, and the process might be made perfectly direct and definitive, by the previous preparation of a Table of Polar-Magnet-Deviation; and I proceeded therefore at once to compute the Table which is appended to this paper. Of this Table I will now give a short description.

The table is a Table of double-entry. One of the arguments is the "Modulus," which is the same as the proportion of AB to AC in fig. 1. It is given to every ·01 from ·00 to ·80. The other argument is the "Apparent Azimuth of the Ship's Head from the Neutral Position," which is the same as the "apparent azimuth of the polar magnet" or "azimuth of the polar magnet as measured from the disturbed position of the compass-needle," or the angle EBF in fig. 1. This is used as the argument of the Table, because, in the examination of the disturbance of ships' compasses, it is usually most convenient to fix the ship in position by means of its own compass; and in fact all the observations supplied to me have been made in positions of the ship so determined. As the observations of deviation of ships' compasses are usually made from "point" to "point" of azimuth, the division of the circle here employed is that by points and decimals of a point. The Table is carried to 8 points only, as the polar-magnet-deviations from 8 to 16 points are the same in reversed order; and those from 16 to 32 points are the same as those from 0 to 16 points with change of sign. At the bottom of each column is the "Mean of all the Polar-Magnet-Deviations for each value of the Modulus," which is necessary for enabling us to determine the value of the modulus in any given case.

In ascertaining, from a given series of observed compass-deviations, the neutral position and modulus to be used in the application of this Table, it will be necessary to recognize the existence of a deviation following very nearly the law of quadrantal deviation, and the given numbers must therefore be so combined that quadrantal deviation will be *ipso facto* eliminated. This will be done by so arranging the process that the numbers for a whole semicircle of apparent azimuth will be added together algebraically. This being understood, we may now proceed with advantage to investigate the nature of the terms produced by combining the effects of the polar-magnet-force and the quadrantal force.

Use the notation of the paper of 1839, as far as it goes, and use also the following notation:—

In fig. 1, let CA represent the terrestrial horizontal force multiplied by $(1-\mathrm{M})$, M being a constant peculiar to each ship.

μ the modulus, or the proportion of AB to CA. It will be remarked that SP in fig. 3 is the representative of AB in fig. 1.

α the angle QSP, fig. 3, or the starboard angle made by the compound polar-magnet-force with the ship's keel.

A the true eastern azimuth of the ship's head.

A' the eastern azimuth of the ship's head as referred to the needle disturbed by polar-magnet-force only.

A'' the eastern azimuth of the ship's head as referred to the needle disturbed by polar-magnet-force and quadrantal force.

$\left.\begin{array}{l}\mathrm{A}+\alpha\\ \mathrm{A}'+\alpha\\ \mathrm{A}''+\alpha\end{array}\right\}$ the corresponding azimuths of the compound polar-magnet-force. $\mathrm{A}+\alpha$ is the same as the angle BAD in fig. 1.

Δ' the compass-deviation to the east produced by polar-magnet-force only $=\mathrm{A}-\mathrm{A}'$ $=(\mathrm{A}+\alpha)-(\mathrm{A}'+\alpha)$.

Δ'' the additional deviation produced by the quadrantal force $=\mathrm{A}'-\mathrm{A}''=(\mathrm{A}'+\alpha)$ $-(\mathrm{A}''+\alpha)$.

And the following double equation is accurate:—

$$\frac{\sin\Delta'}{\mu}=\sin\overline{\mathrm{A}'+\alpha}=\frac{\sin\overline{\mathrm{A}+\alpha}}{\sqrt{\{1+2\mu\cos\overline{\mathrm{A}+\alpha}+\mu^2\}}}.$$

Then, neglecting MP only, the formulæ in the paper of 1839 give—

Whole force to north $=\mathrm{I}.\cos\delta.(1-\mathrm{M}).(1+\mu.\cos\overline{\mathrm{A}+\alpha}+\mathrm{P}.\cos 2\mathrm{A})$

Whole force to east $=\mathrm{I}.\cos\delta.(1-\mathrm{M}).(\mu.\sin\overline{\mathrm{A}+\alpha}+\mathrm{P}.\sin 2\mathrm{A})$.

Therefore
$$\tan\overline{\Delta'+\Delta''}=\frac{\mu.\sin\overline{\mathrm{A}+\alpha}+\mathrm{P}.\sin 2\mathrm{A}}{1+\mu.\cos\overline{\mathrm{A}+\alpha}+\mathrm{P}.\cos 2\mathrm{A}}.$$

But
$$\tan\Delta'=\frac{\mu.\sin\overline{\mathrm{A}+\alpha}}{1+\mu.\cos\overline{\mathrm{A}+\alpha}}.$$

Therefore, retaining the complete multiplier of the first power of P, but no higher powers of P,

$$\tan\Delta''=\frac{\mathrm{P}.\sin 2\mathrm{A}+\mu\mathrm{P}.\sin\overline{\mathrm{A}-\alpha}}{1+2\mu.\cos\overline{\mathrm{A}+\alpha}+\mu^2}.$$

This quantity, however, is not that which we shall have occasion to use, for the following reason. The polar-magnet-deviation which we shall take out from the Table is taken for an argument which is referred to the position of the compass-needle as disturbed *by all causes*; it is therefore taken out, not for argument $\mathrm{A}'+\alpha$ (which would give us Δ exactly), but for argument $\mathrm{A}''+\alpha$. Let the quantity

thus taken from the Table be called $\Delta_{\prime}$, and the correction required be called $\Delta_{\prime\prime}$. Then $\Delta_{\prime}+\Delta_{\prime\prime}=\Delta'+\Delta''$; and

$$\Delta_{\prime\prime}=(\Delta'-\Delta_{\prime})+\Delta''=\mu(\sin\overline{A'+\alpha}-\sin\overline{A''+\alpha})+\Delta'' \text{ nearly}$$

$$=\mu(\sin\overline{A''+\alpha+\Delta''}-\sin\overline{A''+\alpha})+\Delta''=\Delta''(1+\mu.\cos\overline{A''+\alpha}) \text{ nearly.}$$

If in the computation of this small quantity we reject powers of μ following the first,

$$\Delta_{\prime\prime}=(1-\mu.\cos\overline{A''+\alpha}).P.(\sin 2A+\mu.\sin\overline{A-\alpha}).$$

But $\quad \sin 2A=\sin 2A''+2\mu.\cos 2A''.\sin\overline{A''+\alpha}$ nearly.

After all reductions, $\quad \Delta_{\prime\prime}=P.\sin 2A''+\mu P.\cos 2A''.\sin\overline{A''+\alpha}$.

The first term of this expression is in the very convenient form of a quadrantal term referred to the apparent azimuth of the ship's head. The general influence of the second term is, that it produces no effect on the maxima of the quadrantal terms, that it slightly increases the polar-magnet-deviation when $A''=0$ or $180°$, and slightly diminishes it when $A''=90°$ or $270°$; and this will be practically a sufficient description of its characteristic effects.

But as, in the aggregate of numbers, small terms become sensible which are scarcely sensible in the individual numbers, it will be desirable to ascertain the effect of this on a semicircular group. Combine the term $\mu P.\cos 2A''.\sin\overline{A''+\alpha}$ with the approximate polar-magnet-deviation $\mu.\sin\overline{A''+\alpha}$, and integrate from $A''+\alpha=0$ to $A''+\alpha=\pi$: the result is $2\mu\left(1-\frac{P}{3}\cos 2\alpha\right)$. Without the small term we should have obtained 2μ. Hence it appears that the result for modulus found from semicircular groups, which may be called the "Approximate Modulus," must be multiplied by $1+\frac{P}{3}\cos 2\alpha$ in order to obtain the "True Modulus." Again, conceive the "approximate starboard angle made by the compound polar-magnet-force with the ship's keel" to be $\alpha+\beta$: then a semicircular sum from $A''+\alpha+\beta=\frac{\pi}{2}$ to $A''+\alpha+\beta=\frac{3\pi}{2}$ ought to vanish; the integral between these limits, omitting $P\beta$ and β^2, is $2\left\{\sin\beta-\frac{2P}{3}\sin 2\alpha\right\}$; hence $\beta=\frac{2P}{3}\sin 2\alpha$; and this quantity must be subtracted from the "Approximate Starboard Angle," or $\alpha+\beta$, in order to obtain the "True Starboard Angle," or α.

Thus it appears that, in the column of Tabular Polar-Magnet-Deviations, we are not comparing the tabular deviation due to the modulus μ and the starboard angle α, but that due to the modulus $\mu\left(1-\frac{P}{3}\cos 2\alpha\right)$ and starboard angle $\alpha+\frac{2P}{3}\sin 2\alpha$; and therefore our residual numbers ought to represent

$$\mu.\sin\overline{A''+\alpha}+P.\sin 2A''+\mu P.\cos 2A''.\sin\overline{A''+\alpha}-\mu.\left(1-\frac{P}{3}\cos 2\alpha\right).\sin\left(A''+\alpha+\frac{2P}{3}\sin 2\alpha\right).$$

Expanding the last term, this quantity becomes, after all reductions,

$$\mathrm{P}.\sin 2\mathrm{A}''+\mu\mathrm{P}\left(\frac{1}{2}\sin\overline{3\mathrm{A}''+\alpha}-\frac{1}{6}\sin\overline{\mathrm{A}''+3\alpha}\right).$$

It will scarcely be necessary to tabulate the small terms; an estimate of their general effect can very well be formed in the mind.

The entire process will therefore be the following:—

1. For the nautical terms N., N.b.E., N.N.E., &c., use the numeral reckoning of points 0, 1, 2, &c., as far as 31, which will correspond to N.b.W. And for deviation E and deviation W, use the algebraical signs deviation + and deviation —. It will always be convenient to place the + deviations and the — deviations in separate columns.

2. Clear the deviations of constant error by adding together all the + deviations, adding together all the — deviations, combining them algebraically, taking the mean of the sum, and applying this mean with sign changed to every deviation. The deviations thus corrected will be the base of all the following operations.

3. In writing down, in columns, the corrected deviations, repeat those from 0 to 15 points, in sequence to those from 0 to 31 points; so that the Table contains forty-eight lines.

4. A conjecture will easily be formed as to the approximate value of the azimuth for the "neutral position:" and then two or three neighbouring half-points are to be adopted for trial. Thus, if the azimuth for neutral position appears to be near 3^{p} or 4^{p}, the positions to be tried may be $2^{\mathrm{p}}\cdot5$, $3^{\mathrm{p}}\cdot5$, $4^{\mathrm{p}}\cdot5$.

5. The trial of these azimuths will be effected by dividing the series of observed deviations, not at these azimuths, but at azimuths distant from them 8 points on each side. Thus, to make trial of the assumption $2^{\mathrm{p}}\cdot5$, the observed deviations are to be divided at $26^{\mathrm{p}}\cdot5$ and $10^{\mathrm{p}}\cdot5$. And the criterion will be given by adding algebraically all the deviations from 27^{p} to 10^{p}, both included; a little accuracy will be gained if we also add in a separate sum all the deviations from 11^{p} to 26^{p}, both included, and subtract this sum from the former. It will be remarked that the quadrantal deviation is here eliminated.

6. If our assumption $2^{\mathrm{p}}\cdot5$ for the neutral position were strictly correct, the sum or difference of sums found in the manner just stated would $=0$. As this usually will not prove to be true, we must try the next assumption $3^{\mathrm{p}}\cdot5$ in like manner. The comparison of the sums or differences of sums will give the correction to be applied to $2^{\mathrm{p}}\cdot5$ with very great accuracy. The azimuth thus determined is strictly an "approximate neutral position," and its supplement to 32^{p} is the "approximate starboard angle."

7. The approximate neutral position being thus determined, the observed deviations are to be divided into two groups, one division being at the interval in which the neutral position falls, the other at the interval distant from it by 16^{p}. The algebraic

sums of the deviations in the two groups are to be taken: one is to be subtracted from the other, and the remainder is to be divided by 32. The quotient is the mean deviation. This is to be compared with the Means of Polar-Magnet-Deviations at the foot of the columns of the Table. Two adjacent Tabular Means being found, one greater and one less than the mean deviation just obtained, and the values of modulus corresponding to those two tabular means being noted, there is no difficulty in finding by interpolation the value of modulus corresponding to the mean deviation just obtained. This is the "Approximate Modulus."

8. By use of the approximate neutral position, the angle of apparent azimuth from the neutral position will be formed for every observation. Using this as the argument of Azimuth in the Table, the Polar-Magnet-Deviation is to be taken out for every observation with two tabular values of Modulus, one greater and one less than the approximate modulus just found. Between these, the Polar-Magnet-Deviation will be interpolated for the approximate modulus; and thus the Tabular Polar-Magnet-Deviation corresponding to the Approximate Modulus will be obtained for every observation.

9. Subtracting this Tabular Polar-Magnet-Deviation algebraically from the Observed Deviation, the residual quantity will consist of Quadrantal Deviation, of the small correction $\Delta_{\prime\prime}$, and of errors of observation. Neglecting the two last mentioned, a pretty accurate estimate of the coefficient of quadrantal deviation may be got by omitting the values for 0^p, 8^p, 16^p, 24^p, and dividing the sum of each group of seven numbers by 5; the quotient will be the coefficient, or the Quadrantal Deviation for 4^p, 12^p, 20^p, 28^p. The conversion of this coefficient into abstract number (radius $=1$) gives the numerical coefficient P.

10. The angle $\frac{2}{3}\times$ coefficient of quadrantal deviation $\times$ sine of twice the approximate starboard angle is to be subtracted from the approximate starboard angle to give the "True Starboard Angle." And the approximate modulus is to be multiplied by $1+\frac{P}{3}\times$ cosine of twice the approximate starboard angle to give the "True Modulus."

11. The Headward Modulus = True Modulus $\times$ cosine True Starboard Angle; and the Starboard Modulus = True Modulus $\times$ sine True Starboard Angle. As the modulus is the proportion of the disturbing force to the terrestrial horizontal force (slightly diminished everywhere in the same proportion), we must, for the exhibition of the absolute values of the disturbing forces, multiply these quantities by the terrestrial horizontal force. Then (referring to the statements at the commencement of this paper for the results of theory) we shall have,

Headward Modulus $\times$ Terrestrial Horizontal Force $=\mathrm{H}+\mathrm{N}\times$ Terrestrial Vertical Force,
Starboard Modulus $\times$ Terrestrial Horizontal Force $=\mathrm{S}$,

where H and S are the forces of the ship's subpermanent magnetism in the headward and starboard directions; and N is a constant peculiar to the ship, depending

on the arrangement of the mass of iron, and having relation only to the ship's capacity for induced magnetism, but in no way related to terrestrial magnetism.

If we can reconcile the observations made in the same ship at various localities by making H and S constant, then the subpermanent magnetism is truly permanent. In any case, N must be constant for the same ship.

Perhaps the process of obtaining the various elements of a ship's magnetism will be rendered a little more intelligible by exhibiting the work in a single instance.

Iron-Steamer "Trident," examined at Greenhithe, 1852, September.

1. Deviations as registered, substituting only the 0, 1, 2, 3, &c. points for N., N.b.E., N.N.E., N.E.b.N., &c., and the signs + and − for E. and W.

Apparent azimuth of ship's head.	Deviation. +	Deviation. −	Apparent azimuth of ship's head.	Deviation. +	Deviation. −
p	° ′	° ′	p	° ′	° ′
0		2 55	16	2 30	
1	3 40		17	0 0	
2	9 15		18		2 30
3	12 32		19		5 50
4	15 50		20		9 10
5	17 40		21		11 52
6	19 30		22		14 35
7	19 5		23		16 47
8	18 40		24		19 0
9	17 15		25		20 22
10	15 50		26		21 45
11	14 10		27		22 10
12	12 30		28		20 0
13	11 30		29		16 30
14	9 20		30		13 0
15	5 55		31		7 32

The sum of the + deviations is $+205° 12'$; the sum of the − deviations is $-203° 58'$; the algebraical sum of all is $+1° 14'$; which implies a mean error of $+0° 2'$. Applying the correction $-0° 2'$ to every deviation, the next table is formed.

2 & 3. Deviations as corrected for constant error.

Apparent azimuth of ship's head.	Deviation.		Apparent azimuth of ship's head.	Deviation.	
	+	−		+	−
p	° ′	° ′	p	° ′	° ′
0		2 57	24		19 2
1	3 38		25		20 24
2	9 13		26		21 47
3	12 30		27		22 12
4	15 48		28		20 2
5	17 38		29		16 32
6	19 28		30		13 2
7	19 3		31		7 34
8	18 38		0		2 57
9	17 13		1	3 38	
10	15 48		2	9 13	
11	14 8		3	12 30	
12	12 28		4	15 48	
13	11 28		5	17 38	
14	9 18		6	19 28	
15	5 53		7	19 3	
16	2 28		8	18 38	
17		0 2	9	17 13	
18		2 32	10	15 48	
19		5 52	11	14 8	
20		9 12	12	12 28	
21		11 54	13	11 28	
22		14 37	14	9 18	
23		16 49	15	5 53	

4. The neutral position appears to be somewhere near 1^p, and therefore trial may be made with the two assumptions $0^p{\cdot}5$ and $1^p{\cdot}5$.

5. For trial $0^p{\cdot}5$, the sums must be taken from 9^p to 24^p, and from 25^p to 8^p.

$$\begin{aligned} &\text{Sum from } \overset{p}{9} \text{ to } \overset{p}{24} = +\ \overset{\circ}{88}\ \overset{\prime}{44} - \overset{\circ}{80}\ \overset{\prime}{0} = +\ \overset{\circ}{8}\ \overset{\prime}{44} \\ &\text{Sum from } 25 \text{ to } 8 = +115\ 56 - 124\ 30 = -\ 8\ 34 \\ &\qquad\text{Excess of the first} \ \ldots\ldots \ +17\ 18 \end{aligned}$$

For trial $1^p{\cdot}5$, the sums must be taken from 10^p to 25^p, and from 26^p to 9^p.

$$\begin{aligned} &\text{Sum from } \overset{p}{10} \text{ to } \overset{p}{25} = +\ \overset{\circ}{71}\ \overset{\prime}{31} - \overset{\circ}{100}\ \overset{\prime}{24} = -\overset{\circ}{28}\ \overset{\prime}{53} \\ &\text{Sum from } 26 \text{ to } 9 = +133\ \ 9 - 104\ \ 6 = +29\ \ 3 \\ &\qquad\text{Excess of the first} \ \ldots\ldots \ -57\ 56 \end{aligned}$$

6. A change of 1^p in the assumption has changed the "excess" from $+17^\circ\ 18'$ to $-57^\circ\ 56'$, or has changed it by $75^\circ\ 14'$. Hence, the assumption which would make the "Excess" $=0$ is $0^p{\cdot}5+1^p\times\frac{17^\circ\ 18'}{75^\circ\ 14'}=0^p{\cdot}5+1^p\times0{\cdot}23=0^p{\cdot}5+0^p{\cdot}23=0^p{\cdot}73$. This is the "approximate neutral position"; and its supplement or $31^p{\cdot}27$ is the "approximate starboard angle," or the approximate value of α.

7. The neutral position being $0^p{\cdot}73$, the observed deviations which are to be grouped for ascertaining the approximate modulus are those from 1^p to 16^p in one part, and those from 17^p to 0^p in the other part. The sums are respectively $+204^\circ\ 40'$ and $-204^\circ\ 30'$; the excess of the first is $409^\circ\ 10'$; dividing by 32, the

quotient is 12° 47′. On examining the "Mean of Polar-Magnet-Deviations" at the foot of the columns of the Table, it is found that the Mean corresponding to Modulus 0·34 is 12° 35′, and that corresponding to Modulus 0·35 is 12° 58′. Hence the Modulus for mean 12° 47′ is 0·3452.

8 & 9. The neutral position being $0^{p}\cdot73$, the "Apparent Inclination from Neutral Position" for azimuth of ship's head 0^{p} will be $31^{p}\cdot27$; and so for the others. Then two series of numbers are interpolated from the Table of Polar-Magnet-Deviations for the fractional parts of the points; one for Modulus 0·34, and the other for Modulus 0·35. Between the pairs of corresponding numbers thus found, a third interpolation is made for the fractional part of the Modulus, to 0·3452; and thus are obtained the Tabular Polar-Magnet-Deviations required. Subtracting these from

Apparent azimuth of ship's head.	Apparent inclination from neutral position.	Tabular polar-magnet-deviation. Modulus 0·34.	Tabular polar-magnet-deviation. Modulus 0·35.	Tabular polar-magnet-deviation. Modulus 0·3452.	Excess of corrected observed deviation.	One-fifth of quadrantal group.
p	p	° ′	° ′	° ′	° ′	
0	31·27	− 2 47	− 2 52	− 2 50	(−0 7)	
1	0·27	+ 1 2	+ 1 4	+ 1 3	+2 35	
2	1·27	+ 4 49	+ 4 57	+ 4 53	+4 20	
3	2·27	+ 8 26	+ 8 40	+ 8 33	+3 57	
4	3·27	+11 45	+12 6	+11 56	+3 52	+3° 57′
5	4·27	+14 38	+15 5	+14 52	+2 46	
6	5·27	+16 59	+17 31	+17 16	+2 12	
7	6·27	+18 42	+19 16	+19 0	+0 3	
8	7·27	+19 40	+20 16	+19 59	(−1 21)	
9	8·27	+19 51	+20 27	+20 10	−2 57	
10	9·27	+19 14	+19 50	+19 33	−3 45	
11	10·27	+17 52	+18 24	+18 9	−4 1	
12	11·27	+15 48	+16 16	+16 3	−3 35	−3 33
13	12·27	+13 9	+13 32	+13 21	−1 53	
14	13·27	+10 0	+10 18	+10 9	−0 51	
15	14·27	+ 6 31	+ 6 42	+ 6 37	−0 44	
16	15·27	+ 2 47	+ 2 52	+ 2 50	(−0 22)	
17	16·27	− 1 2	− 1 4	− 1 3	+1 1	
18	17·27	− 4 49	− 4 57	− 4 53	+2 21	
19	18·27	− 8 26	− 8 40	− 8 33	+2 41	
20	19·27	−11 45	−12 6	−11 56	+2 44	+3 19
21	20·27	−14 38	−15 5	−14 52	+2 58	
22	21·27	−16 59	−17 31	−17 16	+2 39	
23	22·27	−18 42	−19 16	−19 0	+2 11	
24	23·27	−19 40	−20 16	−19 59	(+0 57)	
25	24·27	−19 51	−20 27	−20 10	−0 14	
26	25·27	−19 14	−19 50	−19 33	−2 14	
27	26·27	−17 52	−18 24	−18 9	−4 3	
28	27·27	−15 48	−16 16	−16 3	−3 59	−3 30
29	28·27	−13 9	−13 32	−13 21	−3 11	
30	29·27	−10 0	−10 18	−10 9	−2 53	
31	30·27	− 6 31	− 6 42	− 6 37	−0 57	

the corrected observed deviations, we have the excess, which clearly follows with considerable accuracy, a Positive Quadrantal law, perhaps slightly disturbed by the residual small terms in the manner explained above. Its Mean Coefficient is +3° 35′ or $0^{p}\cdot3185$, whose equivalent in abstract number is +0·0626=P.

10. From these numbers, $\frac{2}{3}$ quadrantal coefficient × sine of twice approximate

starboard angle $=-0^{p}\cdot06$; which subtracted from approximate starboard angle gives True Starboard Angle $=31^{p}\cdot33$. And $\frac{P}{3}\times$ cosine of twice approximate starboard angle $=0\cdot020$: adding this to unity and multiplying the Approximate Modulus, we have the True Modulus $=0\cdot352$.

11. Expressing the magnitude of the terrestrial magnetic force in the manner introduced by GAUSS for *Absolute Measure*, and adopting the English foot and English grain as the units of length and weight, the measure of terrestrial horizontal force at Greenhithe is 3·79, and that of terrestrial vertical force is 9·66. Forming the quantities "True Modulus $\times$ cosine True Starboard Angle $\times$ Terrestrial Horizontal Force," and "True Modulus $\times$ sine True Starboard Angle $\times$ Terrestrial Horizontal Force," we have for the 'Trident' at Greenhithe in 1852,

$$+1\cdot375=H+N\times9\cdot663$$
$$-0\cdot182=S;$$

and these results, with that just obtained for the Coefficient of Quadrantal Deviation, are the most advanced that can be obtained from the deviations of the compass in the 'Trident' observed at Greenhithe only.

I shall now exhibit, in a tabular form, the results of the twenty-nine series of deviations which have reached me. Nos. 1 to 13 are extracted from the work of the late Captain JOHNSON, R.N., "On the Deviations of the Compass." The signs of the compass-deviations of the 'Erebus' at St. Helena are changed, on the authority of Colonel SABINE, as conveyed to me by ARCHIBALD SMITH, Esq. Nos. 14 to 29 have been communicated to me by Captain WASHINGTON, R.N., Hydrographer to the Admiralty.

It must be remarked that the first column, in every case, is the registered deviation as given by the observer (a few numbers in brackets being supplied by interpolation), and not the deviation as cleared of mean error or index error. In some cases this mean error is large (thus with the 'Simoom' at Simon's Town it amounts to 1° 47′), and here it greatly modifies the true deviation, and even causes the original deviation to appear less on some points than the residual error. The residual error is formed by computing the polar-magnet-deviation from the approximate elements at the top of the Table, and subtracting it from the deviation corrected for constant mean error only; it therefore contains the quadrantal deviation, the small terms produced by combination of polar-magnet-deviation with quadrantal deviation, and the accidental errors of observation. The coefficients of quadrantal deviation below are formed by omitting the residual errors for 0^{p}, 8^{p}, 16^{p}, 24^{p}, and taking one-fifth part of the sums of the residual errors in the groups between them; and the mean coefficient is formed by changing the signs of the second and fourth coefficients of quadrantal deviation, and taking one-fourth of the algebraical sum. The true elements are formed by correcting the approximate elements in the manner just explained.

No.	1.		2.		3.		4.	
Ship's name	Erebus.							
Place of observation	Gillingham.		Porto Praya.		St. Helena.		Cape of Good Hope.	
Time of observation								
Index correction	+0° 16′		−0° 24′		0° 0′		+0° 19′	
Approximate modulus	·069		·033		·008		·020	
Approx. starboard angle	0ᵖ·40		0ᵖ·93		1ᵖ·88		14ᵖ·98	
	Observed deviation uncorrected.	Residual error.	Observed deviation uncorrected.	Residual error.	Observed deviation uncorrected.	Residual error.	Observed deviation uncorrected.	Residual error.
Apparent azimuth of ship's head. p 0	−0° 6′	(−0° 9′)	+0° 56′	(+0° 11′)	+0° 4′	(−0° 6′)	−0° 24′	(−0° 18′)
1	+0 49	0 0	+1 17	+0 11	+0 16	+0 1	−0 24	−0 6
2	+1 39	+0 6	+1 53	+0 27	+0 28	+0 10	−0 1	+0 31
3	+2 16	+0 5	+2 12	+0 29	+0 51	+0 29	−0 11	+0 34
4	+2 59	+0 14	+2 10	+0 14	+1 10	+0 46	−0 22	+0 35
5	+3 18	+0 7	+2 30	+0 23	+0 48	+0 23	−0 31	+0 37
6	+3 46	+0 17	+2 47	+0 34	+0 57	+0 31	−0 51	+0 25
7	+4 53	+1 13	+2 40	+0 24	+0 55	+0 29	−1 2	+0 21
8	+3 42	(+0 1)	+1 56	(−0 18)	+0 32	(+0 7)	−1 15	(+0 12)
9	+3 17	−0 16	+1 44	−0 25	+0 13	−0 9	−1 34	−0 6
10	+2 50	−0 25	+1 18	−0 40	−0 5	−0 24	−1 43	−0 16
11	+2 21	−0 30	+1 25	+0 5	−0 20	−0 35	−2 1	−0 38
12	+1 53	−0 26	+1 9	−0 19	−0 20	−0 31	−1 53	−0 37
13	+1 23	−0 17	+0 25	−0 44	−0 25	−0 31	−1 41	−0 33
14	+0 48	−0 10	+0 42	−0 5	−0 30	−0 31	−1 26	−0 29
15	+0 19	+0 7	+0 32	+0 6	−0 24	−0 19	−1 14	−0 29
16	−0 28	(+0 7)	+0 39	(+0 36)	−0 28	(−0 18)	−0 39	(−0 7)
17	−0 52	+0 29	−0 10	+0 8	−0 8	+0 7	−0 16	+0 4
18	−1 34	+0 31	+0 2	+0 40	−0 1	+0 17	+0 2	+0 8
19	−2 8	+0 35	−0 9	+0 46	+0 14	+0 36	+0 40	+0 33
20	−2 45	+0 32	−0 26	+0 42	+0 4	+0 28	+0 52	+0 33
21	−3 24	+0 19	−1 34	−0 15	+0 8	+0 33	+1 6	+0 36
22	−4 3	−0 2	−1 24	+0 1	+0 9	+0 35	+1 5	+0 27
23	−4 40	−0 28	−1 49	−0 21	−0 12	+0 14	+1 14	+0 29
24	−4 19	(−0 6)	−1 33	(−0 7)	−0 32	(−0 7)	+1 9	(+0 20)
25	−4 9	−0 4	−1 15	+0 6	−0 29	−0 7	+0 51	+0 1
26	−3 51	−0 4	−1 5	+0 5	−0 25	−0 6	+0 33	−0 16
27	−3 28	−0 5	−1 25	−0 53	−1 3	−0 48	+0 15	−0 30
28	−3 3	−0 12	−1 15	−0 35	−0 40	−0 29	+0 3	−0 35
29	−2 30	−0 18	−0 52	−0 31	−0 33	−0 27	−0 2	−0 32
30	−2 1	−0 31	−0 20	−0 21	−0 27	−0 26	−0 10	−0 29
31	−1 12	−0 28	−0 27	−0 49	−0 2	−0 7	−0 16	−0 23
Quadrantal coefficients	+0° 24′		+0° 32′		+0° 34′		+0° 35′	
	−0 23		−0 24		−0 36		−0 38	
	+0 23		+0 20		+0 34		+0 34	
	−0 20		−0 36		−0 30		−0 33	
Mean quadrantal coefficient	+0 23		+0 28		+0 34		+0 35	
True modulus	·069		·033		·008		·020	
True starboard angle	0ᵖ·40		0ᵖ·92		1ᵖ·86		14ᵖ·99	

No.	5.		6.		7.		8.	
Ship's name	Erebus.		Bloodhound.					
Place of observation	Kerguelen's Land.		Plymouth.		Constantinople.		Piræus.	
Time of observation			1845.		1846.			
Index correction	0° 0′		−0° 27′		−0° 6′		−0° 9′	
Approximate modulus	·067		·259		·185		·161	
Approx. starboard angle	$15^{p}·81$		$31^{p}·15$		$30^{p}·91$		$30^{p}·70$	
Apparent azimuth of ship's head. (p)	Observed deviation uncorrected.	Residual error.	Observed deviation uncorrected.	Residual error.	Observed deviation uncorrected.	Residual error.	Observed deviation uncorrected.	Residual error.
0	+0° 8′	(0° 0′)	− 1° 0′	(+1° 0′)	− 4° 20′	(−2° 10′)	− 1° 45′	(+0° 26′)
1	−0 22	+0 15	+ 3 20	+2 26	+ 0 20	+0 26	+ 0 15	+0 39
2	−1 1	+0 20	+ 7 15	+3 28	+ 4 0	+2 1	+ 2 55	+1 30
3	−1 31	+0 31	+10 50	+4 18	+ 7 0	+3 1	+ 7 15	+4 4
4	−2 9	+0 29	+13 20	+4 15	+ 9 0	+3 9	+ 8 35	+3 46
5	−2 13	+0 54	+14 40	+3 22	+10 20	+2 50	+10 20	+4 3
6	−3 1	+0 30	+15 0	+1 53	+11 20	+2 29	+11 0	+3 30
7	−3 31	+0 14	+15 0	+0 33	+11 50	+1 55	+ 9 55	+1 26
8	−3 48	(+0 3)	+14 0	(−1 14)	+12 50	(+2 17)	+ 9 15	(+0 9)
9	−3 53	−0 4	+13 20	−2 6	+10 30	−0 17	+ 8 5	−1 17
10	−4 12	−0 35	+11 50	−3 13	+ 9 0	−1 39	+ 6 35	−2 44
11	−3 51	−0 33	+10 20	−3 47	+ 6 50	−3 13	+ 5 35	−3 19
12	−3 20	−0 30	+ 9 20	−3 17	+ 5 30	−3 35	+ 4 15	−3 52
13	−2 50	−0 34	+ 7 50	−2 50	+ 3 0	−4 47	+ 3 15	−3 48
14	−2 4	−0 28	+ 6 20	−2 1	+ 2 50	−3 20	+ 2 55	−2 48
15	−1 10	−0 16	+ 4 20	−1 23	+ 2 40	−1 41	+ 2 35	−1 35
16	−0 21	(−0 13)	+ 2 40	(−0 14)	+ 2 20	(−0 2)	+ 2 45	(+0 16)
17	+0 44	+0 7	+ 1 20	+1 20	+ 1 30	+1 12	+ 1 15	+0 33
18	+1 53	+0 32	− 0 50	+2 3	+ 0 40	+2 27	+ 1 25	+2 32
19	+2 33	+0 31	− 2 40	+2 58	− 0 10	+3 37	+ 1 35	+4 28
20	+3 23	+0 45	− 5 20	+2 51	− 2 40	+2 59	− 0 5	+4 26
21	+3 46	+0 39	− 7 10	+3 14	− 4 0	+3 18	− 1 55	+4 4
22	+4 5	+0 34	− 9 50	+2 23	− 6 0	+2 39	− 3 45	+3 27
23	+3 56	+0 11	−11 10	+2 23	− 7 30	+2 13	− 7 5	+1 6
24	+3 40	(−0 11)	−13 0	(+1 20)	−10 0	(+0 21)	− 9 5	(−0 17)
25	+3 35	−0 14	−15 50	−1 18	−11 20	−0 45	−11 45	−2 41
26	+3 11	−0 26	−16 40	−2 31	−12 30	−2 3	−13 5	−4 4
27	+2 37	−0 41	−16 40	−3 27	−11 20	−1 29	−12 25	−3 49
28	+2 1	−0 49	−15 30	−3 47	−12 30	−3 37	−10 45	−2 56
29	+2 7	−0 9	−13 30	−3 44	−11 0	−3 25	− 9 30	−2 45
30	+1 9	−0 27	−11 20	−3 53	− 8 30	−2 32	− 8 45	−3 20
31	+0 26	−0 28	− 6 0	−1 11	− 6 20	−2 11	− 5 0	−1 8
Quadrantal coefficients	+0° 39′ −0 36 +0 40 −0 39		+4° 3′ −3 43 +3 26 −3 58		+3° 10′ −3 42 +3 41 −3 16		+3° 48′ −3 53 +4 7 −4 9	
Mean quadrantal coefficient	+0 38		+3 48		+3 27		+3 59	
True modulus	·068		·264		·189		·164	
True starboard angle	$15^{p}·82$		$31^{p}·22$		$30^{p}·99$		$30^{p}·82$	

No.	9.		10.		11.		12.	
Ship's name	Jackal.						Trident.	
Place of observation	Plymouth.		Tagus.		Piræus.		Greenhithe.	
Time of observation	1845.		1847.		1846.		1846.	
Index correction	−0° 12′		+0° 4′		−0° 4′		−0° 37′	
Approximate modulus	·297		·216		·182		·366	
Approx. starboard angle	31^p·40		31^p·10		31^p·58		0^p·32	
	Observed deviation uncorrected.	Residual error.	Observed deviation uncorrected.	Residual error.	Observed deviation uncorrected.	Residual error.	Observed deviation uncorrected.	Residual error.
Apparent azimuth of ship's head. p 0	−2° 15′	(−0° 27′)	−1° 0′	(+1° 14′)	−0° 40′	(+0° 9′)	+3° 12′	(+1° 17′)
1	+2 40	+1 8	+3 0	+2 49	+3 0	+1 44	+8 25	+2 26
2	+8 58	+4 8	+6 40	+4 5	+6 30	+3 14	+13 44	+3 52
3	+13 7	+5 9	+9 20	+4 27	+8 20	+3 11	+18 37	+5 10
4	+15 18	+4 29	+11 20	+4 19	+10 40	+3 50	+21 7	+4 35
5	+17 15	+3 59	+12 20	+3 27	+11 20	+3 4	+21 45	+2 41
6	+18 7	+2 53	+12 0	+1 36	+12 20	+2 56	+22 15	+1 22
7	+17 47	+1 9	+12 0	+0 30	+10 30	+0 20	+22 26	+0 32
8	+15 35	(−1 54)	+11 40	(−0 31)	+10 0	(−0 33)	+20 18	(−1 46)
9	+14 38	−2 49	+10 20	−2 3	+9 0	−1 30	+18 50	−2 31
10	+13 22	−3 28	+9 20	−2 45	+8 0	−2 5	+16 30	−3 19
11	+11 40	−3 54	+9 0	−2 20	+6 15	−2 59	+13 0	−4 32
12	+9 55	−3 48	+5 40	−4 27	+4 0	−4 4	+11 0	−3 38
13	+8 5	−3 15	+4 40	−3 49	+3 15	−3 20	+7 30	−3 43
14	+5 35	−2 59	+3 20	−3 17	+3 0	−1 51	+6 0	−1 26
15	+4 12	−1 16	+2 40	−1 46	+1 20	−1 37	+2 20	−1 5
16	+2 20	(+0 8)	+2 0	(−0 6)	+0 40	(−0 17)	−0 6	(+0 35)
17	−0 12	+0 56	+1 20	+1 39	−1 0	+0 8	−2 45	+2 0
18	−2 32	+1 54	−1 0	+1 43	−1 20	+1 48	−5 58	+2 40
19	−4 55	+2 39	−1 0	+4 1	−2 40	+2 21	−8 42	+3 31
20	−6 30	+3 55	−3 40	+3 29	−2 40	+4 2	−10 55	+4 23
21	−8 45	+4 7	−4 0	+5 1	−4 40	+3 28	−13 25	+4 25
22	−10 52	+3 58	−7 40	+2 52	−5 40	+3 36	−17 10	+2 29
23	−13 50	+2 24	−10 0	+1 38	−8 20	+1 42	−19 17	+1 23
24	−15 45	(+1 14)	−12 40	(−0 21)	−9 40	(+0 45)	−20 35	(+0 15)
25	−17 25	−0 22	−13 20	−0 49	−11 20	−0 58	−21 22	−1 15
26	−18 25	−1 59	−15 20	−3 7	−12 0	−2 3	−21 12	−2 37
27	−18 25	−3 15	−15 0	−3 32	−12 40	−3 34	−19 40	−3 22
28	−17 15	−3 56	−14 40	−4 25	−11 5	−3 9	−18 15	−4 51
29	−15 45	−4 49	−14 40	−6 3	−9 40	−3 13	−14 40	−4 41
30	−11 55	−3 45	−9 20	−2 35	−8 0	−3 17	−9 38	−3 26
31	−7 25	−2 21	−5 40	−1 6	−4 30	−1 41	−3 50	−1 39
Quadrantal coefficients	+4° 35′ −4 18 +3 59 −4 5		+4° 15′ −4 5 +4 5 −4 19		+3° 40′ −3 29 +3 25 −3 35		+4° 8′ −4 3 +4 10 −4 22	
Mean quadrantal coefficient	+4 14		+4 11		+3 32		+4 11	
True modulus	·305		·220		·186		·375	
True starboard angle	31^p·46		31^p·19		31^p·61		0^p·29	

No.	13.		14.		15.		16.	
Ship's name	Trident.		Pandora.				Mæander.	
Place of observation	Malta.		Plymouth.		Auckland.		Sheerness.	
Time of observation	1847.		1851, February.		1853, January.		1852, September.	
Index correction	−0° 38′		+0° 47′		+0° 43′		+0° 15′	
Approximate modulus	·240		·043		·045		·021	
Approx. starboard angle	31^p·64		0^p·28		14^p·50		2^p·33	
Apparent azimuth of ship's head. (p)	Observed deviation uncorrected.	Residual error.	Observed deviation uncorrected.	Residual error.	Observed deviation uncorrected.	Residual error.	Observed deviation uncorrected.	Residual error.
0	+1° 19′	(+1° 40′)	+0° 10′	(+0° 48′)	0° 0′	(−0° 2′)	+0° 30′	(+0° 14′)
1	+4 29	+2 8	+0 30	+0 40	−0 4	+0 24	+0 45	+0 18
2	+6 59	+2 0	+0 50	+0 32	−0 45	+0 13	+0 35	−0 3
3	+11 19	+3 52	+0 50	+0 7	−1 33	−0 5	+0 30	−0 16
4	+14 9	+4 29	+1 45	+0 41	−1 30	+0 21	+0 45	−0 7
5	+14 59	+3 26	+1 20	−0 1	−1 56	+0 26	+0 55	0 0
6	+15 29	+2 28	+1 50	+0 16	−1 50	+0 52	+1 0	+0 4
7	+14 29	+0 29	+1 55	+0 15	−2 35	+0 23	+1 0	+0 6
8	+13 19	(−1 9)	+2 5	(+0 24)	−2 40	(+0 31)	+0 30	(−0 19)
9	+12 9	−2 15	+2 0	+0 23	−3 27	−0 11	+0 30	−0 11
10	+10 9	−3 38	+1 20	−0 7	−3 25	−0 9	+0 30	−0 2
11	+9 9	−3 29	+0 50	−0 22	−3 45	−0 34	+0 30	+0 9
12	+7 9	−3 55	−0 25	−1 18	−3 23	−0 25	+0 20	+0 12
13	+6 9	−2 56	−1 10	−1 39	−3 28	−0 46	+0 25	+0 31
14	+4 59	−1 47	−0 20	−0 23	−2 50	−0 28	0 0	+0 19
15	+3 39	−0 37	−0 40	−0 15	−2 16	−0 20	0 0	+0 33
16	+2 29	(+0 52)	−0 45	(+0 11)	−1 35	(−0 7)	−0 10	(+0 36)
17	+0 19	+1 24	−1 25	−0 1	−0 36	+0 22	−0 35	+0 22
18	−1 21	+2 22	−1 0	+0 52	+0 20	+0 48	−1 40	−0 32
19	−2 51	+3 20	−1 50	+0 27	+0 50	+0 48	−1 40	−0 24
20	−5 1	+3 23	−2 0	+0 38	+1 26	+1 1	−2 10	−0 48
21	−7 21	+2 56	−2 10	+0 45	+1 0	+0 4	−2 0	−0 35
22	−9 31	+2 14	−2 40	+0 28	+1 10	−0 6	−1 40	−0 4
23	−10 41	+2 3	−3 0	+0 14	+0 55	−0 37	−1 30	−0 6
24	−12 51	(+0 21)	−3 40	(−0 25)	+1 40	(−0 5)	−1 30	(−0 11)
25	−14 21	−1 13	−4 17	−1 6	+2 36	+0 46	−1 25	−0 14
26	−14 21	−1 50	−3 50	−0 49	+1 35	−0 15	−0 40	+0 32
27	−15 1	−3 39	−3 50	−1 4	+0 47	−0 58	−0 40	+0 21
28	−14 21	−4 33	−2 30	−0 3	+0 30	−1 2	−0 20	+0 18
29	−11 31	−3 42	−2 40	−0 37	+0 45	−0 31	−0 20	+0 4
30	−8 41	−3 11	−1 20	+0 17	+0 5	−0 51	−0 20	−0 9
31	−4 21	−1 21	−0 50	+0 19	+1 5	+0 40	−0 15	−0 28
Quadrantal coefficients	+3° 46′ −3 43 +3 32 −3 54		+0° 30′ −0 44 +0 41 −0 37		+0° 31′ −0 35 +0 28 −0 26		0° 0′ +0 18 −0 25 +0 5	
Mean quadrantal coefficient	+3 44		+0 38		+0 30		−0 12	
True modulus	·245		·044		·045		·021	
True starboard angle	31^p·67		0^p·27		14^p·52		2^p·32	

No.	17.		18.		19.		20.	
Ship's name	Mæander.		Virago.				Plumper.	
Place of observation	Simon's Bay.		Plymouth.		Valparaiso.		Portsmouth.	
Time of observation	1853, March.		1851, September.		1852, September.		1853, September.	
Index correction	+0° 23′		−0° 19′		+0° 9′		+0° 27′	
Approximate modulus	·044		·129		·012		·106	
Approx. starboard angle	15^p·80		0^p·58		6^p·25		0^p·90	
Apparent azimuth of ship's head.	Observed deviation uncorrected.	Residual error.	Observed deviation uncorrected.	Residual error.	Observed deviation uncorrected.	Residual error.	Observed deviation uncorrected.	Residual error.
0^p	−1° 0′	(−0° 43′)	+1° 0′	(−0° 10′)	+1° 0′	(+0° 31′)	+0° 35′	(−0° 2′)
1	−1 0	−0 13	+2 50	+0 15	+1 40	+1 9	+2 20	+0 33
2	−1 0	+0 16	+4 0	+0 5	+2 20	+1 49	+3 40	+0 50
3	−1 10	+0 32	+5 0	−0 7	+2 20	+1 50	+5 0	+1 14
4	−2 40	−0 34	+6 30	+0 23	+2 20	+1 52	+5 55	+1 23
5	−2 40	−0 15	+8 0	+1 5	+2 30	+2 6	+6 45	+1 38
6	−3 12	−0 32	+9 40	+2 13	+2 20	+2 1	+6 35	+1 5
7	−2 40	+0 10	+9 40	+1 58	+0 20	+0 8	+6 0	+0 23
8	(−2 55)	(−0 1)	+8 40	(+0 59)	−0 30	(−0 35)	+5 45	(+0 13)
9	−3 10	−0 18	+7 20	−0 3	−1 0	−0 57	+4 40	−0 33
10	−2 55	−0 11	+6 40	−0 8	−1 20	−1 9	+3 45	−0 56
11	−2 25	+0 7	+4 30	−1 29	−2 0	−1 42	+2 50	−1 6
12	−2 10	+0 4	+3 0	−1 57	−2 10	−1 43	(+1 45)	−1 17
13	−1 50	+0 2	+2 0	−1 43	−2 40	−2 7	(+0 40)	−1 20
14	−1 0	+0 26	+1 0	−1 22	−2 40	−2 1	(−0 25)	−1 17
15	−0 10	+0 48	+0 40	−0 17	−1 20	−0 37	−1 30	−1 11
16	−0 50	(−0 21)	−0 50	(−0 18)	−0 10	(+0 37)	−1 45	(−0 16)
17	0 0	−0 1	−1 20	+0 37	−0 10	+0 39	−1 50	+0 49
18	+0 50	+0 20	−2 20	+0 57	0 0	+0 49	−2 40	+1 2
19	+1 0	+0 4	−3 0	+1 29	+0 50	+1 38	−3 40	+0 58
20	+0 50	−0 30	−3 35	+1 54	+0 50	+1 36	−4 25	+0 59
21	+1 20	−0 19	−5 20	+0 57	−1 30	−0 48	−4 35	+1 24
22	+1 50	−0 4	−6 30	+0 19	+0 50	+1 27	−4 55	+1 27
23	+2 0	−0 4	−7 10	−0 6	+0 20	+0 50	−5 35	+0 54
24	+2 0	(−0 8)	−8 20	(−1 17)	−0 20	(+0 3)	−6 15	(+0 9)
25	+2 40	+0 34	−8 20	−1 35	−1 0	−0 45	−6 35	−0 30
26	+1 40	−0 18	−7 40	−1 30	−1 0	−0 53	−6 25	−0 52
27	+1 57	+0 11	−6 20	−0 59	−1 30	−1 30	−6 0	−1 12
28	+1 50	+0 22	−6 0	−1 41	−1 0	−1 9	−5 30	−1 36
29	+1 20	+0 14	−3 20	−0 15	−1 0	−1 15	(−4 20)	−1 28
30	+1 10	+0 30	−0 50	+0 54	−1 0	−1 21	−3 10	−1 26
31	0 0	−0 12	+0 40	+0 59	−0 10	−0 35	−1 5	−0 32
Quadrantal coefficients	−0° 9′ +0 10 −0 9 +0 14		+1° 10′ −1 24 +1 13 −0 49		+2° 11′ −2 3 +1 14 −1 30		+1° 25′ −1 32 +1 31 −1 31	
Mean quadrantal coefficient	−0 11		+1 9		+1 44		+1 30	
True modulus	·044		·130		·012		·106	
True starboard angle	15^p·80		0^p·56		6^p·18		0^p·87	

No.	21.		22.		23.		24.	
Ship's name	**Plumper.**		**Spy.**				**Trident.**	
Place of observation	St. Catherine's.		Sheerness.		St. Paul's Loando.		Greenhithe.	
Time of observation	1852, April.		1854, August.		1852, December.		1852, September.	
Index correction	−0° 3′		+1° 35′		+0° 15′		−0° 2′	
Approximate modulus	·048		·040		·077		·345	
Approx. starboard angle	1p·55		27p·56		31p·93		31p·27	
	Observed deviation uncorrected.	Residual error.	Observed deviation uncorrected.	Residual error.	Observed deviation uncorrected.	Residual error.	Observed deviation uncorrected.	Residual error.
Apparent azimuth of ship's head. p	° ′	° ′	° ′	° ′	° ′	° ′	° ′	° ′
0	+1 0	(+0 7)	−5 0	(−1 41)	−0 40	(−0 21)	− 2 55	(−0 7)
1	+2 30	+1 7	−5 0	−2 0	+0 20	−0 13	+ 3 40	+2 35
2	+3 20	+1 30	−3 0	−0 22	+1 20	−0 3	+ 9 15	+4 20
3	+3 20	+1 8	0 0	+2 14	+2 20	+0 10	+12 32	+3 57
4	+3 40	+1 11	+1 20	+3 7	+3 10	+0 19	+15 50	+3 52
5	+4 0	+1 18	+0 15	+1 35	+3 40	+0 16	+17 40	+2 46
6	+4 10	+1 22	+0 10	+1 3	+2 50	−1 0	+19 30	+2 12
7	+3 20	+0 33	+0 40	+1 9	+3 30	−0 35	+19 5	+0 3
8	+2 30	(−0 11)	0 0	(+0 7)	+4 10	(−0 1)	+18 40	(−1 21)
9	+1 40	−0 47	+0 40	+0 29	+4 30	+0 23	+17 15	−2 57
10	+0 40	−1 30	+0 20	−0 5	+4 40	+0 48	+15 50	−3 45
11	+0 30	−1 17	+0 10	−0 25	+3 30	+0 1	+14 10	−4 1
12	−0 20	−1 40	+0 10	−0 30	+3 20	+0 24	+12 30	−3 35
13	−0 45	−1 34	+0 10	−0 29	+2 0	−0 16	+11 30	−1 53
14	−0 45	−1 2	+0 10	−0 24	+1 30	+0 1	+ 9 20	−0 51
15	−0 50	−0 35	−1 0	−1 23	+0 20	−0 20	+ 5 55	−0 44
16	−0 50	(−0 3)	−1 40	(−1 49)	0 0	(+0 11)	+ 2 30	(−0 22)
17	−0 40	+0 37	−1 0	−0 50	−1 0	+0 3	0 0	+1 1
18	−0 20	+1 24	−0 40	−0 8	−1 50	+0 3	− 2 30	+2 21
19	−0 40	+1 26	−0 30	+0 26	−3 10	−0 30	− 5 50	+2 41
20	−0 30	+1 53	0 0	+1 23	−3 50	−0 29	− 9 10	+2 44
21	−1 0	+1 36	−1 30	+0 20	−4 10	−0 16	−11 52	+2 58
22	−1 20	+1 22	−2 30	−0 13	−4 10	+0 10	−14 35	+2 39
23	−2 0	+0 41	−1 30	+1 11	−4 50	−0 15	−16 47	+2 11
24	−2 30	(+0 5)	−2 10	(+0 53)	−4 30	(+0 11)	−19 0	(+0 57)
25	−3 0	−0 39	−3 0	+0 21	−4 25	+0 12	−20 22	−0 14
26	−3 20	−1 16	−1 30	+2 5	−4 10	+0 12	−21 45	−2 14
27	−3 30	−1 49	−3 20	+0 25	−4 0	−0 1	−22 10	−4 3
28	−3 0	−1 46	−5 30	−1 40	−3 0	+0 26	−20 0	−3 59
29	−2 0	−1 17	−5 0	−1 11	−2 40	+0 6	−16 30	−3 11
30	−1 30	−1 19	−5 50	−2 6	−1 40	+0 19	−13 0	−2 53
31	0 0	−0 21	−5 0	−1 27	−1 0	+0 10	− 7 32	−0 57
Quadrantal coefficients	+1° 38′		+1° 21′		−0° 13′		+3° 57′	
	−1 41		−0 33		+0 12		−3 33	
	+1 48		+0 26		−0 15		+3 19	
	−1 41		−0 43		+0 17		−3 30	
Mean quadrantal coefficient	+1 42		+0 46		−0 14		+3 35	
True modulus	·049		·040		·077		·352	
True starboard angle	1p·49		27p·60		31p·93		31p·33	

No.	25.		26.		27.	
Ship's name	Trident.		Vulcan.			
Place of observation	Rio Janeiro.		Portsmouth.		Simon's Bay.	
Time of observation	1852, November.		1852, July.		1853, February.	
Index correction	$+0^\circ\ 8'$		$+0^\circ\ 13'$		$-1^\circ\ 8'$	
Approximate modulus	·216		·155		·271	
Approx. starboard angle	31p·22		15p·58		15p·73	
	Observed deviation uncorrected.	Residual error.	Observed deviation uncorrected.	Residual error.	Observed deviation uncorrected.	Residual error.
Apparent azimuth of ship's head. p	° ′	° ′	° ′	° ′	° ′	° ′
0	− 1 0	(+0 59)	− 0 45	(−1 16)	+ 3 20	(+1 23)
1	+ 2 0	+1 35	− 0 55	+0 19	+ 3 0	+4 5
2	+ 5 0	+2 11	− 1 5	+1 51	+ 2 0	+6 3
3	+ 8 30	+3 24	− 1 22	+3 9	+ 0 35	+7 25
4	+11 0	+3 47	− 1 40	+4 19	− 3 5	+6 13
5	+13 0	+3 59	− 3 22	+3 49	− 8 0	+3 24
6	+13 40	+3 10	− 5 4	+3 5	−13 10	−0 9
7	+13 20	+1 47	− 6 46	+2 0	−18 35	−4 30
8	+12 0	(−0 12)	− 8 30	(+0 36)	−17 49	(−3 16)
9	+11 0	−1 19	− 9 47	−0 43	−16 40	−2 15
10	+ 9 0	−2 58	−11 5	−2 23	−15 15	−1 35
11	+ 8 0	−3 9	−10 32	−2 32	−15 10	−2 51
12	+ 6 30	−3 23	−10 0	−3 0	−14 20	−3 51
13	+ 4 0	−4 15	− 8 50	−3 4	−12 55	−4 42
14	+ 3 10	−3 8	− 7 40	−3 23	− 7 30	−1 56
15	+ 3 0	−1 6	− 5 0	−2 20	− 5 20	−2 37
16	+ 1 20	(−0 23)	− 2 20	(−1 23)	+ 0 55	(+0 36)
17	0 0	+0 41	+ 1 25	+0 37	+ 4 35	+1 14
18	− 0 24	+2 41	+ 5 10	+2 40	+ 8 10	+1 51
19	− 2 20	+3 2	+ 7 20	+3 15	+12 30	+3 24
20	− 4 0	+3 29	+ 9 30	+4 0	+14 35	+3 1
21	− 6 0	+3 17	+10 5	+3 20	+16 55	+3 15
22	− 7 40	+3 6	+10 40	+2 57	+20 30	+5 13
23	− 9 40	+2 9	+ 9 55	+1 35	+17 50	+1 29
24	−11 20	(+1 8)	+ 9 10	(+0 30)	+17 30	(+0 41)
25	−13 20	−0 45	+ 7 40	−0 58	+16 30	−0 11
26	−15 0	−2 46	+ 6 10	−2 6	+12 0	−3 56
27	−15 0	−3 35	+ 4 40	−2 54	+10 25	−4 10
28	−16 0	−5 51	+ 3 10	−3 24	+ 8 30	−4 15
29	−12 0	−3 29	+ 2 2	−3 18	+ 6 50	−3 39
30	− 9 0	−2 26	+ 0 55	−2 56	+ 4 0	−3 50
31	− 6 0	−1 38	+ 0 5	−2 9	+ 3 40	−1 19
Quadrantal coefficients	+3° 59′ −3 52 +3 41 −4 6		+3° 42′ −3 29 +3 41 −3 33		+4° 30′ −3 57 +3 53 −4 16	
Mean quadrantal coefficient	+3 54		+3 36		+4 9	
True modulus	·221		·158		·277	
True starboard angle	31p·29		15p·62		15p·76	

No.	28.		29.	
Ship's name	Simoom.			
Place of observation	Portsmouth.		Simon's Town.	
Time of observation	1852, September.		1853, October.	
Index correction	+0° 7′		+1° 47′	
Approximate modulus	·368		·235	
Approx. starboard angle	30p·20		31p·03	
	Observed deviation uncorrected.	Residual error.	Observed deviation uncorrected.	Residual error.
Apparent azimuth of ship's head. p 0	− 7° 40′	(−0° 14′)	− 4° 0′	(+0° 20′)
1	− 1 35	+1 50	+ 0 10	+1 53
2	+ 4 30	+3 47	+ 5 30	+4 36
3	+ 9 20	+4 31	+ 8 30	+5 4
4	+13 15	+4 31	+10 40	+4 53
5	+17 10	+4 47	+11 0	+3 10
6	+18 10	+2 38	+11 20	+1 49
7	+19 15	+1 6	+11 45	+0 58
8	+20 20	(+0 16)	+10 30	(−1 3)
9	+19 45	−1 26	+ 8 55	−2 53
10	+19 10	−1 40	+ 7 25	−4 6
11	+16 50	−4 0	+ 6 30	−4 13
12	+14 50	−4 34	+ 5 15	−4 11
13	+12 50	−4 22	+ 4 45	−2 47
14	+10 45	−3 36	+ 4 30	−1 10
15	+ 8 40	−2 17	+ 1 45	−1 33
16	+ 7 20	(+0 8)	+ 0 50	(+0 4)
17	+ 4 20	+1 9	− 1 0	+0 51
18	+ 1 20	+2 17	− 2 5	+2 23
19	− 1 40	+3 23	− 4 10	+2 50
20	− 4 40	+4 18	− 5 40	+3 42
21	− 8 10	+4 27	− 7 40	+3 44
22	−11 40	+4 6	− 9 20	+3 45
23	−16 10	+2 13	−11 20	+3 1
24	−20 20	(−0 2)	−15 20	(−0 13)
25	−22 17	−0 52	−16 30	−1 8
26	−24 15	−3 11	−17 0	−1 55
27	−25 10	−4 6	−19 0	−4 43
28	−24 50	−5 12	−18 20	−5 20
29	−22 20	−4 54	−16 20	−5 14
30	−18 30	−3 55	−11 15	−2 1
31	−12 30	−1 19	− 7 40	−0 48
Quadrantal coefficients	+4° 38′ −4 23 +4 23 −4 42		+4° 29′ −4 11 +4 3 −4 14	
Mean quadrantal coefficient	+4 31		+4 14	
True modulus	·375		·240	
True starboard angle	30p·37		31p·12	

I shall first proceed to consider the quadrantal deviations in these ships. It will be remembered that, according to theory, the coefficient of quadrantal deviation in each ship ought to be sensibly the same in all localities; but that the coefficient in one ship may differ in any degree from that in another ship.

Coefficients of Quadrantal Deviation.

1. Wood-built sailing-ships.

In the Erebus, at	Gillingham (No. 1)	$+0^{\circ}\ 23'$
	Porto Praya (No. 2)	+0 28
	St. Helena (No. 3)	+0 34
	Cape of Good Hope (No. 4)	+0 35
	Kerguelen's Land (No. 5)	+0 38
In the Pandora, at	Plymouth (No. 14)	+0 38
	Auckland (No. 15)	+0 30
In the Mæander, at	Sheerness (No. 16)	−0 12
	Simon's Bay (No. 17)	−0 11
In the Spy, at	Sheerness (No. 22)	+0 46
	St. Paul's Loando (No. 23)	−0 14

The accordance of the numbers in the three first instances is very remarkable; and the more so because the compound polar magnetism has changed considerably. In the Spy there is a discordance, but not important in nautical experiments. It will be seen, on referring to the columns of Residual Error for the Spy, that there is general irregularity.

2. Wood-built steamers.

In the Virago, at	Plymouth (No. 18)	$+1^{\circ}\ 9'$
	Valparaiso (No. 19)	+1 44
In the Plumper, at	Portsmouth (No. 20)	+1 30
	St. Catherine's (No. 21)	+1 42

The agreement is sufficiently close.

3. Iron-built steamers.

In the Bloodhound, at	Plymouth (No. 6)	$+3^{\circ}\ 48'$
	Constantinople (No. 7)	+3 27
	Piræus (No. 8)	+3 59
In the Jackal, at	Plymouth (No. 9)	+4 14
	Lisbon (No. 10)	+4 11
	Piræus (No. 11)	+3 32

In the Trident, at .	Greenhithe (No. 12).	+4° 11′
	Malta (No. 13)	+3 44
	Greenhithe (No. 24).	+3 35
	Rio de Janeiro (No. 25) . . .	+3 54
In the Vulcan, at. .	Portsmouth (No. 26)	+3 36
	Simon's Bay (No. 27)	+4 9
In the Simoom, at .	Portsmouth (No. 28)	+4 31
	Simon's Town (No. 29) . . .	+4 14

The general accordance here is extremely good. The petty discordances appear to be purely accidental. It is evident, at least, that they are not dependent on the geographical locality. Thus at (8) the Piræus produces the largest and at (11) the smallest in the group; at (12) Greenhithe produces the largest and at (24) the smallest; at (27) Simon's Bay produces the larger and at (29) the smaller. Nor have I been able to connect these differences with any other law. Regarding their accidental character as established, they give a measure of the range of accident in these observations, and they show that that in the Spy, though large, is not excessive.

I think it therefore certain that this part of the theory is entirely supported by the observations; and therefore that this quadrantal deviation may be perfectly neutralized in all localities by a mass of soft iron placed in the manner described at the beginning of this paper, leaving only a deviation which follows accurately in every place, separately considered, the laws of polar-magnet-deviation, and which therefore in every place, separately considered, may be neutralized by the application of permanent steel magnets.

I shall now proceed to consider the deductions from the two elements of polar-magnet-deviation, namely the starboard angle of the polar-magnet-force and the modulus. For this purpose, I premise the following elements of terrestrial magnetism. The forces are expressed in Gauss's method, adopting as units the English foot and the English grain. For some of the elements I am indebted to the kindness of Colonel Sabine: others were obtained from other sources. None were furnished to me precisely in the form in which they are here exhibited, and some calculation therefore has been required to adapt them to my wants. It is possible that they may be affected by trifling inaccuracies.

	Horizontal Force.	Vertical Force.
1. Gillingham	3·78	+ 9·94
2. Porto Praya	6·26	+ 6·38
3. St. Helena	5·97	− 1·97
4. Cape of Good Hope. .	4·56	− 6·08
5. Kerguelen's Land . .	3·88	−10·68
6. Plymouth	3·82	+ 9·67

	Horizontal Force.	Vertical Force.
7. Constantinople	5·63	+ 7·34
8. Piræus	5·85	+ 6·85
9. Plymouth	3·82	+ 9·67
10. Lisbon	4·62	+ 9·19
11. Piræus	5·85	+ 6·85
12. Greenhithe	3·79	+ 9·66
13. Malta	5·74	+ 7·03
14. Plymouth	3·82	+ 9·67
15. Auckland	6·32	−11·32
16. Sheerness	3·78	+ 9·67
17. Simon's Bay	4·46	− 6·19
18. Plymouth	3·82	+ 9·67
19. Valparaiso	7·17	− 5·23
20. Portsmouth	3·83	+ 9·63
21. St. Catherine's	6·48	− 2·54
22. Sheerness	3·78	+ 9·67
23. St. Paul's Loando	5·57	− 3·09
24. Greenhithe	3·79	+ 9·66
25. Rio de Janeiro	6·49	− 1·49
26. Portsmouth	3·83	+ 9·63
27. Simon's Bay	4·46	− 6·19
28. Portsmouth	3·83	+ 9·63
29. Simon's Town	4·46	− 6·19

From these, with the starboard angle and the modulus, the resolved polar-magnet-force in the two directions of "headward" and "starboard" are formed by the rules given above. It will be remembered that H is the ship's subpermanent magnetism headward, S the subpermanent magnetism to the starboard side, and N a constant of capacity for induced magnetism peculiar to each ship. As the total directive force at Greenhithe is 3·79, a change of disturbing force represented by $\frac{3·79}{57}$, or ·066 nearly, would produce at Greenhithe a change of disturbance whose maximum is 1° nearly; and so, *mutatis mutandis*, at other places.

1. *Wood-built Sailing Ships.*

The Erebus.

1.	$H+N\times 9·94=+0·261$	$S=+0·020$
2.	$H+N\times 6·38=+0·202$	$S=+0·037$
3.	$H-N\times 1·97=+0·043$	$S=+0·017$
4.	$H-N\times 6·08=-0·090$	$S=+0·018$
5.	$H-N\times 10·68=-0·262$	$S=+0·010$

H and S have small positive values, but so small that their combination would not produce, in the Thames, an error of half a degree. N has a well-marked positive value. In this ship the magnetism would be sensibly corrected, by placing (by trial) a mass of soft iron abaft the compass and at a lower level, in such a position as to correct the deviation with head east and head west, and then placing a mass of soft iron at the level of the compass, starboard or larboard, so as to correct the combination of the original quadrantal deviation and the new quadrantal deviation produced by the first corrector; and this would be sensibly effective, without change, in all localities. Or, permanent magnets might be applied to neutralize the errors at the cardinal points, and soft iron at the level of the compass, starboard or larboard, to correct the quadrantal deviation; the soft iron would then be effective in all latitudes, but one of the magnets would require alteration in different latitudes, and would require reversion in opposite hemispheres.

The Pandora.

14.	$H+N\times 9{\cdot}67=+0{\cdot}166$	$S=+0{\cdot}009$
15.	$H-N\times 11{\cdot}32=-0{\cdot}272$	$S=+0{\cdot}082$

S has changed sufficiently to produce at Auckland (No. 15) a disturbance whose maximum is 40′. If this be neglected, the compass may be sensibly corrected in the same manner as for the Erebus. H is small.

The Mæander.

16.	$H+N\times 9{\cdot}67=+0{\cdot}070$	$S=+0{\cdot}034$
17.	$H-N\times 6{\cdot}19=-0{\cdot}195$	$S=+0{\cdot}008$

H would appear to have a value of $-0{\cdot}091$, which at Sheerness would produce a deviation of 1° 20′. S is practically insensible. This ship would require for perfect correction a weak magnet with its marked end towards the stern, in addition to the soft iron as in the Erebus and Pandora. It will probably be better to use, for the polar-magnet-correction, a magnet alone, adjusting or reversing it as may be necessary.

The Spy.

22.	$H+N\times 9{\cdot}67=+0{\cdot}097$	$S=-0{\cdot}113$
23.	$H-N\times 3{\cdot}09=+0{\cdot}431$	$S=-0{\cdot}006$

If the headward subpermanent magnetism has not changed, H is positive and N is negative. These forces would require correctors in positions opposite to those of the Mæander. S seems to have changed, to an amount which would produce at Sheerness a deviation of 1° 30′. It will probably be best to correct the polar-magnet-deviation by adjustible magnets.

2. *Wood-built Steamers.*

The Virago.

18. $H+N\times 9{\cdot}67=+0{\cdot}493$ $S=+0{\cdot}055$
19. $H-N\times 5{\cdot}23=+0{\cdot}029$ $S=+0{\cdot}079$

S presents no sufficient evidence of change. H and N are both positive: and the correction of polar-magnet-deviation would be made, either by a magnet with marked end towards the head, and soft iron as is described for the Erebus, or by an adjustible magnet.

The Plumper.

20. $H+N\times 9{\cdot}63=+0{\cdot}402$ $S=+0{\cdot}069$
21. $H-N\times 2{\cdot}54=+0{\cdot}301$ $S=+0{\cdot}091$

The remarks on the Virago apply also to the Plumper.

3. *Iron-built Steamers.*

The Bloodhound.

6. $H+N\times 9{\cdot}67=+0{\cdot}997$ $S=-0{\cdot}153$
7. $H+N\times 7{\cdot}34=+1{\cdot}043$ $S=-0{\cdot}209$
8. $H+N\times 6{\cdot}85=+0{\cdot}931$ $S=-0{\cdot}220$

The evidence for a distinct value of N is not very clear. There seem to have been changes in the values of H and S (subpermanent magnetism) which on the whole would produce, at the stations Nos. 7 and 8, a maximum deviation of nearly 1°. The correction of polar-magnet-deviation should be made by adjustible magnets.

The Jackal.

9. $H+N\times 9{\cdot}67=+1{\cdot}157$ $S=-0{\cdot}123$
10. $H+N\times 9{\cdot}19=+1{\cdot}005$ $S=-0{\cdot}162$
11. $H+N\times 6{\cdot}85=+1{\cdot}084$ $S=-0{\cdot}082$

The remarks on the Bloodhound will nearly apply to the Jackal. The changes in H and S would produce at the stations Nos. 10 and 11 a maximum deviation of a little more than 1°.

The Trident.

12. $H+N\times 9{\cdot}66=+1{\cdot}419$ $S=+0{\cdot}080$
13. $H+N\times 7{\cdot}03=+1{\cdot}402$ $S=-0{\cdot}091$
24. $H+N\times 9{\cdot}66=+1{\cdot}323$ $S=-0{\cdot}175$
25. $H-N\times 1{\cdot}49=+1{\cdot}418$ $S=-0{\cdot}198$

There seems to be good reason for thinking that N is insensible, that H has not sensibly changed, but that S has changed gradually, in the course of several years,

by a quantity which at station No. 25 would produce a maximum effect of 2°. The change in the voyage between No. 24 and No. 25 is nearly insensible.

The Vulcan.

26. $H+N\times 9{\cdot}63=-0{\cdot}603$ $S=+0{\cdot}046$
27. $H-N\times 6{\cdot}19=-1{\cdot}236$ $S=+0{\cdot}059$

In this instance, as in some others, we feel greatly the want of observations after the ship's return, to inform us whether the ship's subpermanent magnetism has really undergone a change. Assuming that it has not (and it is certain that S has not sensibly changed), then H has a sensible negative value and N a sensible positive value: and the correction for all stations would be effected by magnets and masses of iron as has been described for the Mæander. But it would probably be better to rely solely on adjustible magnets for the correction of the polar-magnet-disturbance.

The Simoom.

28. $H+N\times 9{\cdot}63=+1{\cdot}364$ $S=-0{\cdot}451$
29. $H-N\times 6{\cdot}19=+1{\cdot}055$ $S=-0{\cdot}184$

The change in the value of S would produce at the station No. 29 a maximum error of about 3° 40′. If the whole change in the compound headward force depended upon H, that change would also produce an error of nearly the same magnitude; and the combination of the two would produce, as the total result of the change of subpermanent magnetism, an error of about 5° 30′. But it is probable that N has some positive value, and that the change of H is not so great.

I shall now state what appear to be the just practical inferences from the preceding investigations.

1. At any place, the deviation of the compass in any ship, whether wood-built or iron-built, may be accurately represented as the effect of the combination of two forces, of which one alone would produce a disturbance following the law of polar-magnet-deviation, and the other alone would produce a disturbance following the law of quadrantal deviation.

2. Consequently, at any place the deviation of the compass may be accurately corrected by well-known mechanical methods; namely by a magnet in the athwart-ship direction, fixed at a distance determined by trial, for correcting the deviation when the ship's head is N. or S.; by a magnet in the head-and-stern direction, also at a distance determined by trial, for correcting the deviation when the ship's head is E. or W.; and by a mass of unmagnetized iron, at the same level as the compass, in the athwart-ship line or in the head-and-stern line according to circumstances (usually in the former), also at a distance determined by trial, for correcting the deviation when the ship's head is N.E., S.E., S.W. or N.W.

3. For the same ship, the mass of unmagnetized iron, if adjusted at one port, will produce its due effect at all parts of the world, without ever requiring change or adjustment. The quadrantal deviation may thus be accurately corrected without difficulty, leaving only the polar-magnet-deviation uncorrected.

4. The elements of polar-magnet-deviation are liable to changes, but of very different amounts in different ships. In some (as the Trident), even in the voyage of an iron steamer from the Thames to Rio Janeiro, the ship's subpermanent magnetism is so little altered, that, if the compass were rigorously corrected in the Thames, it would (as to sense) be rigorously correct at Rio Janeiro; in others there is such a change, in going to the Cape of Good Hope, that the compass might be in error 5° or 6°. This is nearly the greatest error that appears in the observations discussed above.

5. It is therefore imperatively the duty of every captain of a ship, particularly of an iron-built ship, to examine the state of the compasses at every opportunity. For the correctness of the compasses may be vitiated, not only by the changes in the polar-magnetism of the ship, but also by changes in the intensity of the magnets used for the correction. But as the correction of the quadrantal deviation is not liable to any doubt whatever, it is sufficient, for ascertaining the existence and recording the amount of error of the polar-magnet-deviation, to observe the error when the ship's head is N. or S., and when it is E. or W.

6. From whatever cause the changes in the elements of polar-magnet-deviation arise (whether from a real change in the subpermanent magnetism of the ship, or from the variation of that part of induced magnetism which is similar to polar-magnetism but which changes in different magnetic latitudes), they may be precisely corrected by readjusting the position of the magnets, leaving the unmagnetized iron undisturbed. And the change (if there is any) in the intensity of the correcting magnets will also be corrected, as to its effect on the compass, by the same readjustment of position.

7. It is therefore highly desirable that the magnets should be mounted in such a manner that their distance from the compass can be delicately changed. And, as the easiest way of preserving a register of the ship's magnetism, it is desirable that there should be means of registering the positions of the magnets.

8. In a ship's first voyage, there are no means of correcting the errors of the compass at different parts of the earth, except by such adjustment of the distances of the magnets. But if, on the ship's return to England, her subpermanent magnetism is found to be unaltered (which affords presumption that it has been unaltered during the voyage), and if the elements of magnetism have been registered either by record of the positions of the correcting magnets or by such discussions as those which occupy this Memoir, then it will be possible to correct by magnets that part of the polar-magnet-deviation which is due to subpermanent magnetism only (and which, alone, would be sensible at the magnetic equator), and to correct the remain-

ing part by unmagnetized iron, as is described above for the Erebus; and then the correction would be complete in all parts of the earth.

9. But, practically, it will perhaps always be easier and safer to readjust the positions of the magnets (as in art. 6.) whenever the directions of one of the magnetic points N. and S., and one of the magnetic points E. and W., can be truly ascertained. This can always be done in harbour, in a very short time. Probably this can also be done at sea, in fine weather, by reference to a compass carried high up the ships' masts. It can also be done with the aid of astronomical observations and of a knowledge of the local "variation" or "declination." In all cases, the mere adjustment of the magnets is an extremely rapid process.

10. On reviewing the results of the preceding examinations, I think that I am justified in denouncing any system of navigating a ship by forming a table of compass-deviations at the starting port, and using that table until means of correction can be obtained from observations, as dangerous; and I think that it ought to be at once discontinued. It does not in the smallest degree provide against the effects of possible change in the ship's subpermanent magnetism during the interval in which no observations are obtained (which, with sometimes a minute change in the powers of the magnets, is the only risk to which the method of mechanical correction is liable); and, as it does not recognize the effect of the variation in the magnitude of terrestrial horizontal magnetism at different places (which alters the compass-deviation by changing the proportion of the ship's subpermanent magnetism to the terrestrial horizontal magnetism, upon which proportion the compass-deviation depends), it gratuitously introduces a class of errors which are entirely avoided by correcting the compass by magnets and soft iron. Thus, in the instance of the Trident (24) and (25), sailing from Greenhithe to Rio Janeiro: suppose that there had been no good opportunity of making observations of azimuth on the voyage; on the ship's arrival at Rio Janeiro, the table of deviations formed at Greenhithe would have been found erroneous by 6° or 7° in one direction with head eastward, and erroneous by 8° or 9° in the opposite direction with head westward. But if the compass had been corrected by magnets and soft iron at Greenhithe, it would have been correct at Rio Janeiro without an error approaching to a single degree. The change of compass-deviation, in fact, has been produced, not by the change of the ship's subpermanent magnetism (which has been sensibly constant), but by the change in the magnitude of the earth's directive magnetism, which change has altered the proportion of the ship's invariable magnetism to the earth's variable magnetism; and if this proportion had been reduced to zero by neutralization of the ship's magnetism by means of magnets, the variation of the proportion as depending on the variation of the earth's magnetism would also have been destroyed. What has been said in regard to the errors arising during the whole voyage, applies, in a proportionate degree, to the errors arising during a part of the voyage: if there had been valid observations

after making half the voyage, the errors perhaps would have been only half as great; but these errors would have been equally gratuitous.

In other instances, such as that of the Simoom, in which the change of subpermanent magnetism is real and unusually great, the tabular method (supposing, for illustration, that there had been no opportunity of sufficiently investigating the errors during the whole voyage) would have united the gratuitous errors with the errors produced by the real change, and would have produced at the Cape of Good Hope an error of 11°; whereas, if the correction by magnets had been used, the error would have been under 6°. At intermediate places, as the neighbourhood of St. Helena, where the earth's directive force differs still more from that in England, the gratuitous error would have been much greater, and the error really depending on change in the ship would probably have been less, as occurring in an earlier part of the voyage.

The mere comparison of magnitudes of errors, however, in this way, does not sufficiently exhibit the disadvantage of the method of "Tables of Deviations." It is an important defect that no good new table can be formed, without observations for the error on numerous points of azimuth; whereas the operations for readjustment of magnets require observations on only two points of azimuth. And, I apprehend, that the necessity of using a table at all (that is, of steering by one nominal course when another course is intended) is, especially in difficult channels, a very serious evil, from which the method of steering by a corrected compass is entirely free.

11. I have alluded above to the possible changes in the energy of the correcting magnets; but I am bound to state that these changes (when ordinary care is taken for the conservation of the magnets) are, to the best of my knowledge, extremely minute. It is known, as a matter of experience, that the diminution of the subpermanent magnetism of a new iron ship, though small, is usually greater than that of the magnets; inasmuch as it usually becomes necessary to increase the distance of the magnets from the compass.

I subjoin the Table of Polar Magnet Deviations, which has been used in the preceding investigations, and which may perhaps be useful, in future, for similar investigations.

TABLE

OF

POLAR-MAGNET-DEVIATIONS.

Table of Polar-Magnet-Deviations,

Apparent Azimuth from Neutral Position in points and decimals.				Modulus.										
				·00	·01	·02	·03	·04	·05	·06	·07	·08	·09	·10
				Corresponding Polar-Magnet-Deviation, in degrees and minutes.										
+ p	+ p	− p	− p	° ′	° ′	° ′	° ′	° ′	° ′	° ′	° ′	° ′	° ′	° ′
0·0	16·0	16·0	32·0	0 0	0 0	0 0	0 0	0 0	0 0	0 0	0 0	0 0	0 0	0 0
0·1	15·9	16·1	31·9	0 0	0 1	0 1	0 2	0 3	0 4	0 4	0 5	0 6	0 7	0 7
0·2	15·8	16·2	31·8	0 0	0 2	0 3	0 4	0 6	0 7	0 8	0 10	0 11	0 13	0 14
0·3	15·7	16·3	31·7	0 0	0 2	0 4	0 6	0 9	0 11	0 13	0 15	0 17	0 19	0 21
0·4	15·6	16·4	31·6	0 0	0 3	0 5	0 8	0 11	0 14	0 16	0 19	0 22	0 25	0 27
0·5	15·5	16·5	31·5	0 0	0 4	0 7	0 10	0 14	0 17	0 20	0 24	0 27	0 31	0 34
0·6	15·4	16·6	31·4	0 0	0 4	0 8	0 12	0 16	0 20	0 24	0 28	0 32	0 36	0 40
0·7	15·3	16·7	31·3	0 0	0 5	0 9	0 14	0 19	0 24	0 28	0 33	0 38	0 43	0 47
0·8	15·2	16·8	31·2	0 0	0 5	0 11	0 16	0 22	0 27	0 32	0 38	0 43	0 48	0 53
0·9	15·1	16·9	31·1	0 0	0 6	0 12	0 18	0 24	0 30	0 36	0 42	0 48	0 54	1 0
1·0	15·0	17·0	31·0	0 0	0 7	0 13	0 20	0 27	0 34	0 40	0 47	0 54	1 1	1 7
1·1	14·9	17·1	30·9	0 0	0 8	0 15	0 22	0 30	0 37	0 44	0 52	0 59	1 7	1 14
1·2	14·8	17·2	30·8	0 0	0 8	0 16	0 24	0 32	0 40	0 48	0 56	1 4	1 12	1 20
1·3	14·7	17·3	30·7	0 0	0 9	0 17	0 26	0 35	0 44	0 52	1 1	1 9	1 18	1 27
1·4	14·6	17·4	30·6	0 0	0 9	0 19	0 28	0 38	0 47	0 56	1 6	1 15	1 24	1 33
1·5	14·5	17·5	30·5	0 0	0 10	0 20	0 30	0 40	0 50	1 0	1 10	1 20	1 30	1 40
1·6	14·4	17·6	30·4	0 0	0 11	0 21	0 32	0 43	0 54	1 4	1 15	1 25	1 36	1 46
1·7	14·3	17·7	30·3	0 0	0 11	0 22	0 34	0 45	0 56	1 7	1 19	1 30	1 41	1 53
1·8	14·2	17·8	30·2	0 0	0 12	0 24	0 36	0 48	1 0	1 11	1 23	1 35	1 47	1 59
1·9	14·1	17·9	30·1	0 0	0 13	0 25	0 38	0 50	1 3	1 15	1 28	1 40	1 53	2 6
2·0	14·0	18·0	30·0	0 0	0 13	0 26	0 40	0 53	1 6	1 19	1 32	1 45	1 59	2 12
2·1	13·9	18·1	29·9	0 0	0 14	0 27	0 41	0 55	1 9	1 22	1 36	1 50	2 4	2 18
2·2	13·8	18·2	29·8	0 0	0 15	0 29	0 44	0 58	1 12	1 26	1 41	1 55	2 10	2 24
2·3	13·7	18·3	29·7	0 0	0 15	0 30	0 45	1 0	1 15	1 30	1 45	2 0	2 15	2 30
2·4	13·6	18·4	29·6	0 0	0 16	0 31	0 47	1 3	1 19	1 34	1 50	2 5	2 21	2 36
2·5	13·5	18·5	29·5	0 0	0 16	0 32	0 49	1 5	1 21	1 37	1 54	2 10	2 26	2 42
2·6	13·4	18·6	29·4	0 0	0 17	0 34	0 51	1 8	1 25	1 41	1 58	2 15	2 32	2 48
2·7	13·3	18·7	29·3	0 0	0 18	0 35	0 53	1 10	1 27	1 44	2 2	2 19	2 37	2 54
2·8	13·2	18·8	29·2	0 0	0 18	0 36	0 54	1 12	1 30	1 48	2 6	2 24	2 42	3 0
2·9	13·1	18·9	29·1	0 0	0 19	0 37	0 56	1 15	1 34	1 52	2 11	2 29	2 48	3 6
3·0	13·0	19·0	29·0	0 0	0 19	0 38	0 58	1 17	1 36	1 55	2 14	2 33	2 52	3 11
3·1	12·9	19·1	28·9	0 0	0 20	0 39	0 59	1 19	1 39	1 58	2 18	2 37	2 57	3 17
3·2	12·8	19·2	28·8	0 0	0 20	0 40	1 1	1 21	1 41	2 1	2 22	2 42	3 2	3 22
3·3	12·7	19·3	28·7	0 0	0 21	0 41	1 2	1 23	1 44	2 4	2 25	2 46	3 7	3 28
3·4	12·6	19·4	28·6	0 0	0 21	0 42	1 4	1 25	1 46	2 7	2 29	2 50	3 12	3 33
3·5	12·5	19·5	28·5	0 0	0 22	0 44	1 6	1 28	1 50	2 11	2 33	2 55	3 17	3 39
3·6	12·4	19·6	28·4	0 0	0 23	0 45	1 8	1 30	1 52	2 14	2 37	2 59	3 22	3 44
3·7	12·3	19·7	28·3	0 0	0 23	0 46	1 9	1 32	1 55	2 17	2 40	3 3	3 26	3 49
3·8	12·2	19·8	28·2	0 0	0 24	0 47	1 11	1 34	1 57	2 20	2 44	3 7	3 31	3 54
3·9	12·1	19·9	28·1	0 0	0 24	0 48	1 12	1 36	2 0	2 23	2 47	3 11	3 35	3 59
4·0	12·0	20·0	28·0	0 0	0 24	0 49	1 13	1 38	2 2	2 26	2 51	3 15	3 39	4 4
+	+	−	−											

for Azimuths referred to the Disturbed Compass.

Apparent Azimuth from Neutral Position in points and decimals.				Modulus.										
				·00	·01	·02	·03	·04	·05	·06	·07	·08	·09	·10
				Corresponding Polar-Magnet-Deviation, in degrees and minutes.										
+ p	+ p	− p	− p	° ′	° ′	° ′	° ′	° ′	° ′	° ′	° ′	° ′	° ′	° ′
4·0	12·0	20·0	28·0	0 0	0 24	0 49	1 13	1 38	2 2	2 26	2 51	3 15	3 39	4 4
4·1	11·9	20·1	27·9	0 0	0 25	0 50	1 15	1 40	2 4	2 29	2 54	3 19	3 44	4 9
4·2	11·8	20·2	27·8	0 0	0 25	0 51	1 16	1 41	2 6	2 32	2 57	3 22	3 48	4 13
4·3	11·7	20·3	27·7	0 0	0 26	0 52	1 17	1 43	2 9	2 35	3 0	3 26	3 52	4 18
4·4	11·6	20·4	27·6	0 0	0 26	0 52	1 18	1 44	2 11	2 37	3 3	3 29	3 55	4 22
4·5	11·5	20·5	27·5	0 0	0 26	0 53	1 19	1 46	2 13	2 40	3 6	3 33	3 59	4 26
4·6	11·4	20·6	27·4	0 0	0 27	0 54	1 21	1 48	2 15	2 42	3 9	3 36	4 3	4 30
4·7	11·3	20·7	27·3	0 0	0 27	0 55	1 22	1 50	2 17	2 45	3 12	3 40	4 7	4 35
4·8	11·2	20·8	27·2	0 0	0 28	0 56	1 23	1 51	2 19	2 47	3 15	3 43	4 11	4 39
4·9	11·1	20·9	27·1	0 0	0 28	0 57	1 24	1 53	2 21	2 50	3 18	3 46	4 14	4 43
5·0	11·0	21·0	27·0	0 0	0 28	0 57	1 25	1 54	2 23	2 52	3 21	3 49	4 18	4 47
5·1	10·9	21·1	26·9	0 0	0 29	0 58	1 27	1 56	2 25	2 55	3 24	3 53	4 22	4 51
5·2	10·8	21·2	26·8	0 0	0 29	0 59	1 28	1 58	2 26	2 57	3 26	3 56	4 25	4 54
5·3	10·7	21·3	26·7	0 0	0 29	0 59	1 28	1 58	2 28	2 58	3 28	3 58	4 27	4 57
5·4	10·6	21·4	26·6	0 0	0 30	1 0	1 30	2 0	2 30	3 0	3 30	4 0	4 30	5 0
5·5	10·5	21·5	26·5	0 0	0 30	1 1	1 31	2 1	2 31	3 2	3 32	4 3	4 33	5 4
5·6	10·4	21·6	26·4	0 0	0 30	1 1	1 31	2 2	2 33	3 4	3 34	4 5	4 36	5 7
5·7	10·3	21·7	26·3	0 0	0 31	1 2	1 32	2 4	2 35	3 6	3 37	4 8	4 39	5 10
5·8	10·2	21·8	26·2	0 0	0 31	1 3	1 34	2 5	2 37	3 8	3 39	4 10	4 41	5 13
5·9	10·1	21·9	26·1	0 0	0 31	1 3	1 34	2 6	2 38	3 10	3 41	4 13	4 44	5 16
6·0	10·0	22·0	26·0	0 0	0 32	1 4	1 35	2 7	2 39	3 11	3 43	4 15	4 46	5 18
6·1	9·9	22·1	25·9	0 0	0 32	1 4	1 36	2 8	2 40	3 13	3 45	4 17	4 49	5 21
6·2	9·8	22·2	25·8	0 0	0 32	1 5	1 37	2 9	2 41	3 14	3 46	4 18	4 50	5 23
6·3	9·7	22·3	25·7	0 0	0 32	1 5	1 37	2 10	2 42	3 15	3 47	4 20	4 52	5 25
6·4	9·6	22·4	25·6	0 0	0 32	1 5	1 38	2 11	2 44	3 16	3 48	4 21	4 54	5 27
6·5	9·5	22·5	25·5	0 0	0 33	1 6	1 39	2 12	2 45	3 18	3 50	4 23	4 56	5 29
6·6	9·4	22·6	25·4	0 0	0 33	1 6	1 39	2 12	2 45	3 19	3 52	4 25	4 58	5 31
6·7	9·3	22·7	25·3	0 0	0 33	1 7	1 40	2 13	2 46	3 20	3 53	4 26	4 59	5 33
6·8	9·2	22·8	25·2	0 0	0 33	1 7	1 40	2 14	2 47	3 21	3 54	4 28	5 1	5 35
6·9	9·1	22·9	25·1	0 0	0 33	1 7	1 40	2 14	2 48	3 22	3 55	4 29	5 3	5 37
7·0	9·0	23·0	25·0	0 0	0 34	1 8	1 41	2 15	2 49	3 23	3 56	4 30	5 4	5 38
7·1	8·9	23·1	24·9	0 0	0 34	1 8	1 41	2 15	2 49	3 23	3 57	4 31	5 5	5 39
7·2	8·8	23·2	24·8	0 0	0 34	1 8	1 42	2 16	2 50	3 24	3 58	4 32	5 6	5 40
7·3	8·7	23·3	24·7	0 0	0 34	1 8	1 42	2 16	2 50	3 25	3 59	4 33	5 7	5 41
7·4	8·6	23·4	24·6	0 0	0 34	1 8	1 42	2 16	2 50	3 25	3 59	4 33	5 7	5 42
7·5	8·5	23·5	24·5	0 0	0 34	1 8	1 42	2 17	2 51	3 25	3 59	4 33	5 7	5 42
7·6	8·4	23·6	24·4	0 0	0 34	1 9	1 43	2 17	2 51	3 26	4 0	4 34	5 8	5 43
7·7	8·3	23·7	24·3	0 0	0 34	1 9	1 43	2 17	2 51	3 26	4 0	4 34	5 8	5 43
7·8	8·2	23·8	24·2	0 0	0 34	1 9	1 43	2 18	2 52	3 26	4 0	4 35	5 9	5 44
7·9	8·1	23·9	24·1	0 0	0 34	1 9	1 43	2 18	2 52	3 26	4 1	4 35	5 9	5 44
8·0	8·0	24·0	24·0	0 0	0 34	1 9	1 43	2 18	2 52	3 26	4 1	4 35	5 10	5 44
+	+	−	−											
Mean				0 0	0 22	0 44	1 6	1 28	1 49	2 11	2 33	2 55	3 17	3 39

Table of Polar-Magnet-Deviations,

Apparent Azimuth from Neutral Position in points and decimals.				Modulus.										
				·10	·11	·12	·13	·14	·15	·16	·17	·18	·19	·20
				Corresponding Polar-Magnet-Deviation, in degrees and minutes.										
+ p	+ p	− p	− p	° ′	° ′	° ′	° ′	° ′	° ′	° ′	° ′	° ′	° ′	° ′
0·0	16·0	16·0	32·0	0 0	0 0	0 0	0 0	0 0	0 0	0 0	0 0	0 0	0 0	0 0
0·1	15·9	16·1	31·9	0 7	0 8	0 9	0 9	0 10	0 10	0 11	0 12	0 12	0 13	0 14
0·2	15·8	16·2	31·8	0 14	0 16	0 17	0 18	0 19	0 20	0 22	0 23	0 24	0 26	0 27
0·3	15·7	16·3	31·7	0 21	0 23	0 25	0 27	0 29	0 31	0 33	0 35	0 36	0 39	0 41
0·4	15·6	16·4	31·6	0 27	0 30	0 33	0 36	0 39	0 41	0 44	0 47	0 49	0 52	0 54
0·5	15·5	16·5	31·5	0 34	0 38	0 41	0 45	0 48	0 51	0 54	0 58	1 1	1 5	1 8
0·6	15·4	16·6	31·4	0 40	0 45	0 49	0 53	0 57	1 1	1 5	1 9	1 13	1 17	1 21
0·7	15·3	16·7	31·3	0 47	0 52	0 56	1 1	1 6	1 11	1 16	1 21	1 25	1 30	1 35
0·8	15·2	16·8	31·2	0 53	0 59	1 4	1 10	1 16	1 21	1 27	1 32	1 37	1 43	1 48
0·9	15·1	16·9	31·1	1 0	1 6	1 12	1 19	1 25	1 31	1 37	1 43	1 49	1 55	2 1
1·0	15·0	17·0	31·0	1 7	1 14	1 20	1 27	1 34	1 41	1 48	1 55	2 1	2 8	2 14
1·1	14·9	17·1	30·9	1 14	1 21	1 28	1 36	1 43	1 51	1 59	2 6	2 13	2 21	2 28
1·2	14·8	17·2	30·8	1 20	1 28	1 36	1 45	1 53	2 1	2 10	2 18	2 26	2 34	2 41
1·3	14·7	17·3	30·7	1 27	1 36	1 44	1 53	2 2	2 11	2 20	2 29	2 38	2 46	2 54
1·4	14·6	17·4	30·6	1 33	1 43	1 52	2 2	2 11	2 20	2 30	2 40	2 49	2 58	3 7
1·5	14·5	17·5	30·5	1 40	1 50	2 0	2 10	2 20	2 30	2 41	2 51	3 1	3 11	3 20
1·6	14·4	17·6	30·4	1 46	1 57	2 8	2 19	2 29	2 40	2 51	3 2	3 12	3 23	3 33
1·7	14·3	17·7	30·3	1 53	2 5	2 16	2 28	2 39	2 50	3 1	3 12	3 23	3 35	3 46
1·8	14·2	17·8	30·2	1 59	2 11	2 23	2 36	2 48	2 59	3 11	3 23	3 34	3 46	3 58
1·9	14·1	17·9	30·1	2 6	2 19	2 31	2 44	2 56	3 9	3 21	3 33	3 45	3 58	4 10
2·0	14·0	18·0	30·0	2 12	2 25	2 38	2 51	3 4	3 18	3 31	3 44	3 57	4 10	4 23
2·1	13·9	18·1	29·9	2 18	2 32	2 46	3 0	3 13	3 27	3 41	3 55	4 8	4 22	4 35
2·2	13·8	18·2	29·8	2 24	2 39	2 53	3 8	3 22	3 36	3 50	4 5	4 19	4 34	4 48
2·3	13·7	18·3	29·7	2 30	2 45	3 0	3 15	3 30	3 45	4 0	4 15	4 30	4 45	5 0
2·4	13·6	18·4	29·6	2 36	2 52	3 7	3 23	3 38	3 54	4 10	4 26	4 41	4 57	5 12
2·5	13·5	18·5	29·5	2 42	2 59	3 15	3 31	3 47	4 4	4 20	4 36	4 52	5 8	5 24
2·6	13·4	18·6	29·4	2 48	3 5	3 22	3 39	3 55	4 12	4 29	4 46	5 3	5 20	5 36
2·7	13·3	18·7	29·3	2 54	3 12	3 29	3 47	4 4	4 22	4 39	4 56	5 13	5 31	5 48
2·8	13·2	18·8	29·2	3 0	3 18	3 36	3 54	4 12	4 30	4 48	5 6	5 24	5 42	6 0
2·9	13·1	18·9	29·1	3 6	3 24	3 42	4 1	4 19	4 38	4 57	5 16	5 34	5 53	6 12
3·0	13·0	19·0	29·0	3 11	3 30	3 49	4 9	4 27	4 47	5 6	5 25	5 44	6 4	6 23
3·1	12·9	19·1	28·9	3 17	3 37	3 56	4 16	4 35	4 55	5 15	5 35	5 54	6 14	6 34
3·2	12·8	19·2	28·8	3 22	3 44	4 3	4 23	4 43	5 4	5 24	5 44	6 4	6 25	6 45
3·3	12·7	19·3	28·7	3 28	3 50	4 9	4 30	4 51	5 12	5 33	5 54	6 14	6 35	6 56
3·4	12·6	19·4	28·6	3 33	3 55	4 16	4 38	4 59	5 21	5 42	6 3	6 24	6 46	7 7
3·5	12·5	19·5	28·5	3 39	4 1	4 23	4 45	5 7	5 29	5 51	6 13	6 34	6 56	7 18
3·6	12·4	19·6	28·4	3 44	4 7	4 29	4 52	5 14	5 37	5 59	6 21	6 43	7 6	7 28
3·7	12·3	19·7	28·3	3 49	4 12	4 35	4 58	5 21	5 44	6 7	6 30	6 52	7 15	7 38
3·8	12·2	19·8	28·2	3 54	4 18	4 41	5 5	5 28	5 52	6 15	6 38	7 1	7 25	7 48
3·9	12·1	19·9	28·1	3 59	4 23	4 47	5 11	5 35	5 59	6 23	6 47	7 10	7 34	7 58
4·0	12·0	20·0	28·0	4 4	4 28	4 53	5 17	5 42	6 6	6 30	6 55	7 19	7 44	8 8
+	+	−	−											

for Azimuths referred to the Disturbed Compass.

Apparent Azimuth from Neutral Position in points and decimals.				Modulus. ·10	·11	·12	·13	·14	·15	·16	·17	·18	·19	·20
				Corresponding Polar-Magnet-Deviation, in degrees and minutes.										
+ p	+ p	− p	− p	° ′	° ′	° ′	° ′	° ′	° ′	° ′	° ′	° ′	° ′	° ′
4·0	12·0	20·0	28·0	4 4	4 28	4 53	5 17	5 42	6 6	6 30	6 55	7 19	7 44	8 8
4·1	11·9	20·1	27·9	4 9	4 33	4 58	5 23	5 48	6 13	6 38	7 3	7 28	7 53	8 18
4·2	11·8	20·2	27·8	4 13	4 38	5 4	5 29	5 55	6 20	6 46	7 11	7 36	8 1	8 27
4·3	11·7	20·3	27·7	4 18	4 43	5 9	5 35	6 1	6 27	6 53	7 18	7 44	8 10	8 36
4·4	11·6	20·4	27·6	4 22	4 48	5 15	5 41	6 7	6 33	7 0	7 26	7 52	8 18	8 45
4·5	11·5	20·5	27·5	4 26	4 53	5 20	5 46	6 13	6 40	7 7	7 33	8 0	8 26	8 54
4·6	11·4	20·6	27·4	4 30	4 57	5 24	5 51	6 18	6 46	7 13	7 40	8 7	8 34	9 2
4·7	11·3	20·7	27·3	4 35	5 2	5 29	5 57	6 24	6 52	7 20	7 47	8 15	8 42	9 10
4·8	11·2	20·8	27·2	4 39	5 7	5 35	6 3	6 31	6 59	7 27	7 54	8 22	8 50	9 18
4·9	11·1	20·9	27·1	4 43	5 11	5 40	6 8	6 36	7 4	7 33	8 1	8 29	8 57	9 26
5·0	11·0	21·0	27·0	4 47	5 15	5 44	6 13	6 41	7 10	7 39	8 8	8 36	9 5	9 34
5·1	10·9	21·1	26·9	4 51	5 20	5 49	6 18	6 47	7 16	7 46	8 15	8 44	9 13	9 42
5·2	10·8	21·2	26·8	4 54	5 23	5 53	6 22	6 52	7 21	7 51	8 20	8 50	9 19	9 49
5·3	10·7	21·3	26·7	4 57	5 27	5 57	6 27	6 57	7 27	7 57	8 26	8 56	9 26	9 56
5·4	10·6	21·4	26·6	5 0	5 30	6 1	6 31	7 1	7 31	8 2	8 32	9 2	9 32	10 3
5·5	10·5	21·5	26·5	5 4	5 34	6 5	6 35	7 6	7 37	8 8	8 38	9 9	9 39	10 10
5·6	10·4	21·6	26·4	5 7	5 38	6 9	6 40	7 11	7 42	8 13	8 43	9 14	9 45	10 16
5·7	10·3	21·7	26·3	5 10	5 41	6 13	6 44	7 15	7 46	8 18	8 49	9 20	9 51	10 22
5·8	10·2	21·8	26·2	5 13	5 44	6 16	6 47	7 19	7 50	8 22	8 53	9 25	9 56	10 28
5·9	10·1	21·9	26·1	5 16	5 47	6 19	6 51	7 23	7 55	8 27	8 58	9 30	10 2	10 34
6·0	10·0	22·0	26·0	5 18	5 50	6 22	6 54	7 26	7 58	8 31	9 3	9 35	10 7	10 39
6·1	9·9	22·1	25·9	5 21	5 53	6 25	6 57	7 30	8 2	8 35	9 7	9 39	10 11	10 44
6·2	9·8	22·2	25·8	5 23	5 55	6 28	7 0	7 33	8 6	8 39	9 11	9 44	10 16	10 49
6·3	9·7	22·3	25·7	5 25	5 58	6 31	7 4	7 37	8 10	8 43	9 15	9 48	10 21	10 54
6·4	9·6	22·4	25·6	5 27	6 0	6 33	7 6	7 39	8 12	8 46	9 19	9 52	10 25	10 58
6·5	9·5	22·5	25·5	5 29	6 2	6 36	7 9	7 42	8 15	8 49	9 22	9 56	10 29	11 2
6·6	9·4	22·6	25·4	5 31	6 4	6 38	7 11	7 45	8 18	8 52	9 25	9 59	10 32	11 6
6·7	9·3	22·7	25·3	5 33	6 7	6 41	7 14	7 48	8 21	8 55	9 29	10 3	10 36	11 10
6·8	9·2	22·8	25·2	5 35	6 9	6 43	7 17	7 51	8 24	8 58	9 32	10 6	10 39	11 13
6·9	9·1	22·9	25·1	5 37	6 11	6 45	7 19	7 53	8 27	9 1	9 35	10 8	10 42	11 16
7·0	9·0	23·0	25·0	5 38	6 12	6 46	7 20	7 54	8 28	9 3	9 37	10 11	10 45	11 19
7·1	8·9	23·1	24·9	5 39	6 13	6 48	7 22	7 56	8 30	9 5	9 39	10 14	10 48	11 22
7·2	8·8	23·2	24·8	5 40	6 14	6 49	7 23	7 58	8 32	9 7	9 41	10 16	10 50	11 24
7·3	8·7	23·3	24·7	5 41	6 15	6 50	7 24	7 59	8 33	9 8	9 42	10 17	10 51	11 26
7·4	8·6	23·4	24·6	5 42	6 16	6 51	7 25	8 0	8 34	9 9	9 43	10 18	10 52	11 27
7·5	8·5	23·5	24·5	5 42	6 17	6 52	7 26	8 1	8 35	9 10	9 45	10 20	10 54	11 29
7·6	8·4	23·6	24·4	5 43	6 17	6 52	7 26	8 1	8 36	9 11	9 46	10 21	10 55	11 30
7·7	8·3	23·7	24·3	5 43	6 17	6 52	7 26	8 1	8 36	9 11	9 46	10 21	10 56	11 31
7·8	8·2	23·8	24·2	5 44	6 18	6 53	7 27	8 2	8 37	9 12	9 47	10 22	10 57	11 32
7·9	8·1	23·9	24·1	5 44	6 18	6 53	7 27	8 2	8 37	9 12	9 47	10 22	10 57	11 32
8·0 +	8·0 +	24·0 −	24·0 −	5 44	6 19	6 53	7 28	8 2	8 37	9 12	9 47	10 22	10 57	11 32
Mean				3 39	4 1	4 23	4 45	5 7	5 29	5 52	6 14	6 36	6 58	7 20

Table of Polar-Magnet-Deviations,

Apparent Azimuth from Neutral Position in points and decimals.				Modulus.										
				·20	·21	·22	·23	·24	·25	·26	·27	·28	·29	·30
				Corresponding Polar-Magnet-Deviation, in degrees and minutes.										
+ p	+ p	− p	− p	° ′	° ′	° ′	° ′	° ′	° ′	° ′	° ′	° ′	° ′	° ′
0·0	16·0	16·0	32·0	0 0	0 0	0 0	0 0	0 0	0 0	0 0	0 0	0 0	0 0	0 0
0·1	15·9	16·1	31·9	0 14	0 15	0 15	0 16	0 16	0 17	0 18	0 19	0 19	0 20	0 20
0·2	15·8	16·2	31·8	0 27	0 29	0 30	0 31	0 32	0 34	0 35	0 36	0 37	0 39	0 40
0·3	15·7	16·3	31·7	0 41	0 43	0 45	0 47	0 49	0 51	0 53	0 55	0 57	0 59	1 1
0·4	15·6	16·4	31·6	0 54	0 57	1 0	1 3	1 5	1 8	1 11	1 14	1 16	1 19	1 21
0·5	15·5	16·5	31·5	1 8	1 11	1 14	1 18	1 21	1 25	1 28	1 31	1 34	1 38	1 41
0·6	15·4	16·6	31·4	1 21	1 25	1 29	1 33	1 37	1 41	1 45	1 49	1 53	1 57	2 1
0·7	15·3	16·7	31·3	1 35	1 40	1 44	1 49	1 53	1 58	2 3	2 8	2 12	2 17	2 21
0·8	15·2	16·8	31·2	1 48	1 54	1 59	2 4	2 9	2 15	2 20	2 25	2 30	2 36	2 41
0·9	15·1	16·9	31·1	2 1	2 7	2 13	2 19	2 25	2 31	2 37	2 43	2 49	2 55	3 1
1·0	15·0	17·0	31·0	2 14	2 21	2 27	2 34	2 41	2 48	2 54	3 1	3 7	3 14	3 21
1·1	14·9	17·1	30·9	2 28	2 35	2 42	2 50	2 57	3 5	3 12	3 19	3 26	3 34	3 41
1·2	14·8	17·2	30·8	2 41	2 49	2 57	3 5	3 13	3 21	3 29	3 37	3 45	3 53	4 1
1·3	14·7	17·3	30·7	2 54	3 3	3 11	3 20	3 28	3 37	3 46	3 55	4 3	4 12	4 21
1·4	14·6	17·4	30·6	3 7	3 17	3 26	3 35	3 44	3 54	4 3	4 12	4 21	4 31	4 40
1·5	14·5	17·5	30·5	3 20	3 30	3 40	3 50	4 0	4 10	4 20	4 30	4 40	4 50	5 0
1·6	14·4	17·6	30·4	3 33	3 44	3 54	4 5	4 15	4 26	4 37	4 48	4 58	5 9	5 19
1·7	14·3	17·7	30·3	3 46	3 57	4 8	4 20	4 31	4 43	4 54	5 5	5 16	5 28	5 39
1·8	14·2	17·8	30·2	3 58	4 10	4 22	4 34	4 46	4 58	5 10	5 22	5 34	5 46	5 58
1·9	14·1	17·9	30·1	4 10	4 23	4 36	4 49	5 1	5 14	5 27	5 40	5 52	6 5	6 17
2·0	14·0	18·0	30·0	4 23	4 37	4 50	5 3	5 16	5 30	5 43	5 56	6 9	6 23	6 36
2·1	13·9	18·1	29·9	4 35	4 49	5 3	5 17	5 31	5 45	5 59	6 13	6 27	6 41	6 55
2·2	13·8	18·2	29·8	4 48	5 3	5 17	5 32	5 46	6 1	6 15	6 30	6 44	6 59	7 13
2·3	13·7	18·3	29·7	5 0	5 15	5 30	5 45	6 0	6 16	6 31	6 46	7 1	7 16	7 31
2·4	13·6	18·4	29·6	5 12	5 28	5 44	6 0	6 15	6 31	6 47	7 3	7 18	7 34	7 50
2·5	13·5	18·5	29·5	5 24	5 41	5 57	6 14	6 30	6 47	7 3	7 18	7 35	7 52	8 8
2·6	13·4	18·6	29·4	5 36	5 53	6 10	6 27	6 44	7 1	7 18	7 35	7 52	8 9	8 26
2·7	13·3	18·7	29·3	5 48	6 6	6 23	6 41	6 58	7 16	7 34	7 52	8 9	8 27	8 44
2·8	13·2	18·8	29·2	6 0	6 18	6 36	6 54	7 12	7 31	7 49	8 7	8 25	8 43	9 1
2·9	13·1	18·9	29·1	6 12	6 31	6 49	7 8	7 26	7 45	8 4	8 23	8 41	9 0	9 19
3·0	13·0	19·0	29·0	6 23	6 43	7 2	7 21	7 40	8 0	8 19	8 38	8 57	9 17	9 36
3·1	12·9	19·1	28·9	6 34	6 54	7 14	7 34	7 54	8 14	8 34	8 54	9 13	9 33	9 53
3·2	12·8	19·2	28·8	6 45	7 6	7 26	7 47	8 7	8 28	8 48	9 9	9 29	9 50	10 10
3·3	12·7	19·3	28·7	6 56	7 17	7 38	7 59	8 20	8 41	9 2	9 23	9 44	10 5	10 26
3·4	12·6	19·4	28·6	7 7	7 28	7 50	8 12	8 33	8 55	9 16	9 38	9 59	10 21	10 42
3·5	12·5	19·5	28·5	7 18	7 40	8 2	8 24	8 46	9 8	9 30	9 52	10 14	10 36	10 58
3·6	12·4	19·6	28·4	7 28	7 51	8 13	8 36	8 58	9 21	9 44	10 7	10 29	10 52	11 14
3·7	12·3	19·7	28·3	7 38	8 1	8 24	8 47	9 10	9 34	9 57	10 20	10 43	11 7	11 30
3·8	12·2	19·8	28·2	7 48	8 12	8 35	8 59	9 22	9 46	10 10	10 34	10 57	11 21	11 45
3·9	12·1	19·9	28·1	7 58	8 22	8 46	9 10	9 34	9 59	10 23	10 47	11 11	11 36	12 0
4·0	12·0	20·0	28·0	8 8	8 33	8 57	9 22	9 46	10 11	10 36	11 1	11 25	11 50	12 15
+	+	−	−											

for Azimuths referred to the Disturbed Compass.

Apparent Azimuth from Neutral Position in points and decimals.				Modulus.										
				·20	·21	·22	·23	·24	·25	·26	·27	·28	·29	·30
				Corresponding Polar-Magnet-Deviation, in degrees and minutes.										
+ p	+ p	− p	− p	° ′	° ′	° ′	° ′	° ′	° ′	° ′	° ′	° ′	° ′	° ′
4·0	12·0	20·0	28·0	8 8	8 33	8 57	9 22	9 46	10 11	10 36	11 1	11 25	11 50	12 15
4·1	11·9	20·1	27·9	8 18	8 43	9 8	9 33	9 58	10 23	10 48	11 13	11 38	12 4	12 30
4·2	11·8	20·2	27·8	8 27	8 52	9 18	9 43	10 9	10 34	11 0	11 26	11 52	12 18	12 44
4·3	11·7	20·3	27·7	8 36	9 2	9 28	9 54	10 20	10 46	11 12	11 38	12 5	12 31	12 58
4·4	11·6	20·4	27·6	8 45	9 11	9 38	10 4	10 31	10 57	11 24	11 50	12 17	12 44	13 11
4·5	11·5	20·5	27·5	8 54	9 20	9 47	10 14	10 41	11 8	11 36	12 3	12 30	12 57	13 25
4·6	11·4	20·6	27·4	9 2	9 29	9 57	10 24	10 52	11 19	11 47	12 14	12 42	13 10	13 38
4·7	11·3	20·7	27·3	9 10	9 38	10 6	10 34	11 2	11 30	11 58	12 26	12 54	13 22	13 51
4·8	11·2	20·8	27·2	9 18	9 46	10 15	10 43	11 12	11 40	12 9	12 37	13 6	13 34	14 3
4·9	11·1	20·9	27·1	9 26	9 55	10 24	10 53	11 22	11 50	12 19	12 48	13 17	13 46	14 15
5·0	11·0	21·0	27·0	9 34	10 3	10 32	11 1	11 31	12 0	12 29	12 58	13 28	13 57	14 27
5·1	10·9	21·1	26·9	9 42	10 11	10 41	11 10	11 40	12 9	12 39	13 8	13 38	14 8	14 38
5·2	10·8	21·2	26·8	9 49	10 18	10 48	11 18	11 48	12 18	12 48	13 18	13 48	14 18	14 49
5·3	10·7	21·3	26·7	9 56	10 26	10 56	11 26	11 56	12 27	12 57	13 27	13 58	14 29	15 0
5·4	10·6	21·4	26·6	10 3	10 33	11 3	11 33	12 4	12 35	13 6	13 37	14 8	14 39	15 10
5·5	10·5	21·5	26·5	10 10	10 40	11 11	11 42	12 13	12 44	13 15	13 46	14 18	14 49	15 20
5·6	10·4	21·6	26·4	10 16	10 47	11 18	11 49	12 21	12 52	13 24	13 56	14 27	14 58	15 30
5·7	10·3	21·7	26·3	10 22	10 53	11 25	11 57	12 28	13 0	13 32	14 4	14 36	15 8	15 40
5·8	10·2	21·8	26·2	10 28	11 0	11 32	12 4	12 36	13 8	13 40	14 12	14 44	15 16	15 49
5·9	10·1	21·9	26·1	10 34	11 6	11 38	12 10	12 43	13 15	13 47	14 19	14 52	15 24	15 57
6·0	10·0	22·0	26·0	10 39	11 11	11 44	12 16	12 49	13 21	13 54	14 26	14 59	15 32	16 5
6·1	9·9	22·1	25·9	10 44	11 16	11 49	12 22	12 55	13 27	14 1	14 34	15 7	15 40	16 13
6·2	9·8	22·2	25·8	10 49	11 21	11 54	12 27	13 0	13 33	14 7	14 40	15 14	15 47	16 21
6·3	9·7	22·3	25·7	10 54	11 27	12 0	12 33	13 6	13 39	14 13	14 47	15 21	15 54	16 28
6·4	9·6	22·4	25·6	10 58	11 31	12 5	12 38	13 12	13 45	14 19	14 53	15 27	16 1	16 35
6·5	9·5	22·5	25·5	11 2	11 35	12 9	12 43	13 17	13 50	14 24	14 58	15 33	16 7	16 41
6·6	9·4	22·6	25·4	11 6	11 39	12 13	12 47	13 21	13 55	14 29	15 3	15 38	16 12	16 47
6·7	9·3	22·7	25·3	11 10	11 44	12 18	12 52	13 26	14 0	14 34	15 8	15 43	16 18	16 53
6·8	9·2	22·8	25·2	11 13	11 47	12 21	12 55	13 30	14 4	14 39	15 13	15 48	16 23	16 58
6·9	9·1	22·9	25·1	11 16	11 50	12 25	12 59	13 34	14 8	14 43	15 18	15 53	16 28	17 3
7·0	9·0	23·0	25·0	11 19	11 53	12 28	13 2	13 37	14 12	14 47	15 22	15 57	16 32	17 7
7·1	8·9	23·1	24·9	11 22	11 56	12 31	13 5	13 40	14 15	14 50	15 25	16 0	16 35	17 11
7·2	8·8	23·2	24·8	11 24	11 58	12 33	13 8	13 43	14 18	14 53	15 28	16 3	16 38	17 14
7·3	8·7	23·3	24·7	11 26	12 1	12 36	13 11	13 46	14 21	14 56	15 31	16 6	16 41	17 17
7·4	8·6	23·4	24·6	11 27	12 2	12 38	13 13	13 48	14 23	14 58	15 33	16 9	16 44	17 20
7·5	8·5	23·5	24·5	11 29	12 4	12 39	13 14	13 50	14 25	15 0	15 35	16 11	16 46	17 22
7·6	8·4	23·6	24·4	11 30	12 5	12 40	13 15	13 51	14 26	15 2	15 37	16 13	16 48	17 24
7·7	8·3	23·7	24·3	11 31	12 6	12 41	13 16	13 52	14 27	15 3	15 38	16 14	16 50	17 26
7·8	8·2	23·8	24·2	11 32	12 6	12 42	13 17	13 53	14 28	15 4	15 39	16 15	16 51	17 27
7·9	8·1	23·9	24·1	11 32	12 7	12 43	13 18	13 54	14 29	15 5	15 40	16 16	16 51	17 27
8·0 +	8·0 +	24·0 −	24·0 −	11 32	12 7	12 43	13 18	13 54	14 29	15 5	15 40	16 16	16 51	17 27
Mean				7 20	7 42	8 4	8 26	8 49	9 11	9 34	9 56	10 19	10 41	11 4

Table of Polar-Magnet-Deviations,

Apparent Azimuth from Neutral Position in points and decimals.				Modulus. ·30	·31	·32	·33	·34	·35	·36	·37	·38	·39	·40
				Corresponding Polar-Magnet-Deviation, in degrees and minutes.										
+ p	+ p	− p	− p	° ′	° ′	° ′	° ′	° ′	° ′	° ′	° ′	° ′	° ′	° ′
0·0	16·0	16·0	32·0	0 0	0 0	0 0	0 0	0 0	0 0	0 0	0 0	0 0	0 0	0 0
0·1	15·9	16·1	31·9	0 20	0 21	0 22	0 22	0 23	0 24	0 25	0 25	0 26	0 26	0 27
0·2	15·8	16·2	31·8	0 40	0 42	0 43	0 44	0 46	0 47	0 49	0 50	0 51	0 52	0 54
0·3	15·7	16·3	31·7	1 1	1 3	1 5	1 7	1 9	1 11	1 13	1 15	1 17	1 19	1 21
0·4	15·6	16·4	31·6	1 21	1 23	1 26	1 28	1 31	1 34	1 37	1 39	1 42	1 45	1 48
0·5	15·5	16·5	31·5	1 41	1 44	1 47	1 50	1 54	1 57	2 1	2 4	2 8	2 11	2 15
0·6	15·4	16·6	31·4	2 1	2 5	2 9	2 13	2 17	2 21	2 26	2 30	2 34	2 38	2 42
0·7	15·3	16·7	31·3	2 21	2 25	2 30	2 35	2 40	2 45	2 50	2 55	3 0	3 4	3 9
0·8	15·2	16·8	31·2	2 41	2 46	2 52	2 57	3 3	3 8	3 14	3 19	3 25	3 30	3 36
0·9	15·1	16·9	31·1	3 1	3 7	3 13	3 19	3 25	3 31	3 38	3 44	3 50	3 56	4 3
1·0	15·0	17·0	31·0	3 21	3 28	3 35	3 41	3 48	3 55	4 2	4 8	4 15	4 22	4 29
1·1	14·9	17·1	30·9	3 41	3 48	3 56	4 3	4 11	4 18	4 26	4 33	4 41	4 48	4 56
1·2	14·8	17·2	30·8	4 1	4 9	4 17	4 25	4 33	4 41	4 50	4 58	5 6	5 14	5 22
1·3	14·7	17·3	30·7	4 21	4 29	4 38	4 46	4 55	5 4	5 13	5 21	5 30	5 39	5 48
1·4	14·6	17·4	30·6	4 40	4 49	4 59	5 8	5 18	5 27	5 37	5 46	5 55	6 4	6 14
1·5	14·5	17·5	30·5	5 0	5 10	5 20	5 30	5 40	5 50	6 0	6 10	6 20	6 30	6 40
1·6	14·4	17·6	30·4	5 19	5 30	5 40	5 50	6 1	6 12	6 23	6 33	6 44	6 55	7 6
1·7	14·3	17·7	30·3	5 39	5 50	6 1	6 12	6 24	6 35	6 47	6 58	7 9	7 20	7 32
1·8	14·2	17·8	30·2	5 58	6 10	6 22	6 34	6 46	6 58	7 10	7 21	7 33	7 45	7 57
1·9	14·1	17·9	30·1	6 17	6 29	6 42	6 54	7 7	7 20	7 33	7 45	7 58	8 10	8 23
2·0	14·0	18·0	30·0	6 36	6 49	7 2	7 15	7 28	7 41	7 55	8 8	8 21	8 34	8 48
2·1	13·9	18·1	29·9	6 55	7 8	7 22	7 36	7 50	8 4	8 18	8 31	8 45	8 59	9 13
2·2	13·8	18·2	29·8	7 13	7 27	7 42	7 56	8 11	8 25	8 40	8 54	9 9	9 23	9 38
2·3	13·7	18·3	29·7	7 31	7 46	8 2	8 17	8 32	8 47	9 2	9 17	9 32	9 47	10 2
2·4	13·6	18·4	29·6	7 50	8 5	8 21	8 36	8 52	9 8	9 24	9 39	9 55	10 11	10 27
2·5	13·5	18·5	29·5	8 8	8 24	8 41	8 57	9 14	9 30	9 47	10 3	10 19	10 35	10 52
2·6	13·4	18·6	29·4	8 26	8 43	9 0	9 17	9 34	9 51	10 8	10 25	10 42	10 59	11 16
2·7	13·3	18·7	29·3	8 44	9 1	9 19	9 36	9 54	10 12	10 30	10 47	11 5	11 22	11 40
2·8	13·2	18·8	29·2	9 1	9 19	9 37	9 55	10 13	10 32	10 50	11 8	11 26	11 44	12 3
2·9	13·1	18·9	29·1	9 19	9 37	9 56	10 15	10 34	10 53	11 12	11 30	11 49	12 8	12 27
3·0	13·0	19·0	29·0	9 36	9 55	10 15	10 34	10 54	11 13	11 33	11 52	12 11	12 30	12 50
3·1	12·9	19·1	28·9	9 53	10 13	10 33	10 53	11 13	11 33	11 53	12 13	12 33	12 53	13 13
3·2	12·8	19·2	28·8	10 10	10 30	10 51	11 11	11 32	11 53	12 14	12 34	12 55	13 15	13 36
3·3	12·7	19·3	28·7	10 26	10 47	11 9	11 30	11 51	12 12	12 34	12 55	13 16	13 37	13 58
3·4	12·6	19·4	28·6	10 42	11 4	11 26	11 47	12 9	12 31	12 53	13 15	13 36	13 58	14 20
3·5	12·5	19·5	28·5	10 58	11 20	11 43	12 5	12 28	12 50	13 13	13 35	13 57	14 19	14 42
3·6	12·4	19·6	28·4	11 14	11 37	12 0	12 23	12 46	13 9	13 32	13 54	14 17	14 40	15 3
3·7	12·3	19·7	28·3	11 30	11 53	12 17	12 40	13 4	13 27	13 51	14 14	14 37	15 0	15 24
3·8	12·2	19·8	28·2	11 45	12 9	12 33	12 57	13 21	13 45	14 9	14 33	14 57	15 21	15 45
3·9	12·1	19·9	28·1	12 0	12 24	12 49	13 13	13 38	14 3	14 28	14 52	15 17	15 41	16 6
4·0	12·0	20·0	28·0	12 15	12 40	13 5	13 30	13 55	14 20	14 45	15 10	15 36	16 1	16 26
+	+	−	−											

for Azimuths referred to the Disturbed Compass.

Apparent Azimuth from Neutral Position in points and decimals.				Modulus.										
				·30	·31	·32	·33	·34	·35	·36	·37	·38	·39	·40
				Corresponding Polar-Magnet-Deviation, in degrees and minutes.										
+ p	+ p	− p	− p	° ′	° ′	° ′	° ′	° ′	° ′	° ′	° ′	° ′	° ′	° ′
4·0	12·0	20·0	28·0	12 15	12 40	13 5	13 30	13 55	14 20	14 45	15 10	15 36	16 1	16 26
4·1	11·9	20·1	27·9	12 30	12 55	13 21	13 46	14 11	14 37	15 2	15 28	15 54	16 20	16 46
4·2	11·8	20·2	27·8	12 44	13 10	13 36	14 1	14 27	14 53	15 19	15 45	16 12	16 38	17 5
4·3	11·7	20·3	27·7	12 58	13 24	13 51	14 17	14 43	15 10	15 36	16 3	16 30	16 57	17 24
4·4	11·6	20·4	27·6	13 11	13 38	14 5	14 32	14 59	15 26	15 53	16 20	16 47	17 14	17 42
4·5	11·5	20·5	27·5	13 25	13 52	14 20	14 47	15 14	15 42	16 9	16 36	17 4	17 32	18 0
4·6	11·4	20·6	27·4	13 38	14 6	14 34	15 1	15 29	15 57	16 25	16 53	17 21	17 49	18 18
4·7	11·3	20·7	27·3	13 51	14 19	14 48	15 15	15 44	16 12	16 41	17 9	17 38	18 7	18 36
4·8	11·2	20·8	27·2	14 3	14 32	15 1	15 29	15 58	16 27	16 56	17 25	17 54	18 23	18 53
4·9	11·1	20·9	27·1	14 15	14 44	15 14	15 42	16 12	16 41	17 11	17 40	18 10	18 40	19 10
5·0	11·0	21·0	27·0	14 27	14 56	15 26	15 55	16 25	16 55	17 25	17 55	18 25	18 55	19 26
5·1	10·9	21·1	26·9	14 38	15 8	15 38	16 8	16 38	17 9	17 39	18 9	18 40	19 10	19 41
5·2	10·8	21·2	26·8	14 49	15 19	15 50	16 20	16 51	17 22	17 53	18 23	18 54	19 25	19 56
5·3	10·7	21·3	26·7	15 0	15 31	16 2	16 32	17 3	17 35	18 6	18 37	19 8	19 39	20 11
5·4	10·6	21·4	26·6	15 10	15 41	16 13	16 44	17 15	17 47	18 19	18 50	19 22	19 54	20 26
5·5	10·5	21·5	26·5	15 20	15 52	16 24	16 55	17 27	17 59	18 31	19 3	19 35	20 7	20 40
5·6	10·4	21·6	26·4	15 30	16 2	16 34	17 6	17 38	18 10	18 43	19 15	19 48	20 20	20 53
5·7	10·3	21·7	26·3	15 40	16 12	16 44	17 16	17 49	18 21	18 54	19 27	20 0	20 33	21 6
5·8	10·2	21·8	26·2	15 49	16 21	16 54	17 26	17 59	18 32	19 5	19 38	20 11	20 44	21 18
5·9	10·1	21·9	26·1	15 57	16 30	17 3	17 36	18 9	18 42	19 16	19 49	20 23	20 56	21 30
6·0	10·0	22·0	26·0	16 5	16 38	17 12	17 45	18 18	18 52	19 26	19 59	20 33	21 7	21 41
6·1	9·9	22·1	25·9	16 13	16 47	17 21	17 54	18 27	19 1	19 35	20 9	20 43	21 17	21 52
6·2	9·8	22·2	25·8	16 21	16 55	17 29	18 2	18 36	19 10	19 44	20 18	20 53	21 27	22 2
6·3	9·7	22·3	25·7	16 28	17 2	17 37	18 10	18 45	19 19	19 53	20 27	21 2	21 37	22 12
6·4	9·6	22·4	25·6	16 35	17 9	17 44	18 18	18 53	19 27	20 2	20 37	21 12	21 47	22 22
6·5	9·5	22·5	25·5	16 41	17 16	17 51	18 25	19 0	19 35	20 10	20 45	21 20	21 55	22 31
6·6	9·4	22·6	25·4	16 47	17 22	17 57	18 32	19 7	19 42	20 17	20 52	21 28	22 3	22 39
6·7	9·3	22·7	25·3	16 53	17 28	18 3	18 38	19 13	19 48	20 24	20 59	21 35	22 10	22 46
6·8	9·2	22·8	25·2	16 58	17 33	18 8	18 43	19 18	19 54	20 30	21 5	21 41	22 17	22 53
6·9	9·1	22·9	25·1	17 3	17 38	18 13	18 48	19 23	19 59	20 35	21 11	21 47	22 23	23 0
7·0	9·0	23·0	25·0	17 7	17 42	18 18	18 53	19 28	20 4	20 40	21 16	21 53	22 29	23 6
7·1	8·9	23·1	24·9	17 11	17 46	18 22	18 57	19 33	20 9	20 45	21 21	21 58	22 34	23 11
7·2	8·8	23·2	24·8	17 14	17 50	18 26	19 1	19 37	20 13	20 50	21 26	22 3	22 39	23 16
7·3	8·7	23·3	24·7	17 17	17 53	18 29	19 5	19 41	20 17	20 54	21 30	22 7	22 43	23 20
7·4	8·6	23·4	24·6	17 20	17 56	18 32	19 8	19 44	20 20	20 57	21 33	22 10	22 47	23 24
7·5	8·5	23·5	24·5	17 22	17 58	18 34	19 10	19 47	20 23	21 0	21 36	22 13	22 50	23 27
7·6	8·4	23·6	24·4	17 24	18 0	18 36	19 12	19 49	20 25	21 2	21 39	22 16	22 53	23 30
7·7	8·3	23·7	24·3	17 26	18 2	18 38	19 14	19 51	20 27	21 4	21 41	22 18	22 55	23 32
7·8	8·2	23·8	24·2	17 27	18 3	18 39	19 15	19 52	20 28	21 5	21 42	22 19	22 56	23 34
7·9	8·1	23·9	24·1	17 27	18 3	18 40	19 16	19 53	20 29	21 6	21 43	22 20	22 57	23 35
8·0	8·0	24·0	24·0	17 27	18 3	18 40	19 16	19 53	20 29	21 6	21 43	22 21	22 58	23 35
+	+	−	−											
Mean				11 4	11 27	11 50	12 13	12 35	12 58	13 21	13 44	14 7	14 30	14 53

Table of Polar-Magnet-Deviations,

Apparent Azimuth from Neutral Position in points and decimals.				Modulus.										
				·40	·41	·42	·43	·44	·45	·46	·47	·48	·49	·50
				Corresponding Polar-Magnet-Deviation, in degrees and minutes.										
+	+	−	−											
p	p	p	p	° ′	° ′	° ′	° ′	° ′	° ′	° ′	° ′	° ′	° ′	° ′
0·0	16·0	16·0	32·0	0 0	0 0	0 0	0 0	0 0	0 0	0 0	0 0	0 0	0 0	0 0
0·1	15·9	16·1	31·9	0 27	0 27	0 28	0 29	0 30	0 31	0 31	0 31	0 32	0 33	0 34
0·2	15·8	16·2	31·8	0 54	0 55	0 57	0 58	1 0	1 1	1 2	1 3	1 4	1 5	1 7
0·3	15·7	16·3	31·7	1 21	1 23	1 25	1 27	1 29	1 31	1 33	1 35	1 37	1 39	1 41
0·4	15·6	16·4	31·6	1 48	1 50	1 53	1 56	1 59	2 1	2 4	2 6	2 9	2 12	2 15
0·5	15·5	16·5	31·5	2 15	2 18	2 21	2 24	2 28	2 31	2 35	2 38	2 42	2 45	2 49
0·6	15·4	16·6	31·4	2 42	2 46	2 50	2 54	2 58	3 2	3 6	3 10	3 14	3 18	3 22
0·7	15·3	16·7	31·3	3 9	3 14	3 19	3 24	3 29	3 33	3 38	3 42	3 47	3 51	3 56
0·8	15·2	16·8	31·2	3 36	3 41	3 47	3 52	3 58	4 3	4 8	4 13	4 18	4 23	4 29
0·9	15·1	16·9	31·1	4 3	4 9	4 15	4 21	4 27	4 33	4 39	4 45	4 51	4 57	5 3
1·0	15·0	17·0	31·0	4 29	4 35	4 42	4 49	4 56	5 2	5 9	5 15	5 22	5 29	5 36
1·1	14·9	17·1	30·9	4 56	5 3	5 10	5 17	5 25	5 32	5 40	5 47	5 54	6 1	6 9
1·2	14·8	17·2	30·8	5 22	5 30	5 38	5 46	5 54	6 2	6 10	6 18	6 26	6 34	6 42
1·3	14·7	17·3	30·7	5 48	5 57	6 6	6 15	6 24	6 32	6 41	6 49	6 58	7 6	7 15
1·4	14·6	17·4	30·6	6 14	6 23	6 33	6 42	6 52	7 1	7 11	7 20	7 29	7 38	7 48
1·5	14·5	17·5	30·5	6 40	6 50	7 0	7 10	7 21	7 31	7 41	7 51	8 1	8 11	8 21
1·6	14·4	17·6	30·4	7 6	7 16	7 27	7 37	7 48	7 59	8 10	8 20	8 31	8 42	8 53
1·7	14·3	17·7	30·3	7 32	7 43	7 54	8 5	8 17	8 28	8 40	8 51	9 2	9 13	9 25
1·8	14·2	17·8	30·2	7 57	8 9	8 21	8 33	8 45	8 57	9 10	9 22	9 34	9 46	9 58
1·9	14·1	17·9	30·1	8 23	8 35	8 48	9 0	9 13	9 26	9 39	9 51	10 4	10 17	10 30
2·0	14·0	18·0	30·0	8 48	9 1	9 15	9 28	9 42	9 55	10 9	10 22	10 35	10 48	11 2
2·1	13·9	18·1	29·9	9 13	9 27	9 41	9 55	10 9	10 23	10 38	10 52	11 6	11 20	11 34
2·2	13·8	18·2	29·8	9 38	9 52	10 7	10 21	10 36	10 51	11 6	11 20	11 35	11 50	12 5
2·3	13·7	18·3	29·7	10 2	10 17	10 33	10 48	11 4	11 19	11 35	11 50	12 5	12 21	12 36
2·4	13·6	18·4	29·6	10 27	10 43	10 59	11 15	11 31	11 47	12 3	12 19	12 35	12 51	13 7
2·5	13·5	18·5	29·5	10 52	11 8	11 25	11 41	11 58	12 15	12 32	12 48	13 5	13 21	13 38
2·6	13·4	18·6	29·4	11 16	11 33	11 50	12 7	12 24	12 41	12 59	13 16	13 33	13 50	14 8
2·7	13·3	18·7	29·3	11 40	11 57	12 15	12 33	12 51	13 9	13 27	13 44	14 2	14 20	14 38
2·8	13·2	18·8	29·2	12 3	12 21	12 40	12 58	13 17	13 35	13 54	14 12	14 31	14 49	15 8
2·9	13·1	18·9	29·1	12 27	12 46	13 5	13 24	13 43	14 2	14 22	14 41	15 0	15 19	15 38
3·0	13·0	19·0	29·0	12 50	13 10	13 30	13 49	14 9	14 29	14 49	15 8	15 28	15 48	16 8
3·1	12·9	19·1	28·9	13 13	13 33	13 54	14 14	14 35	14 55	15 16	15 36	15 56	16 16	16 37
3·2	12·8	19·2	28·8	13 36	13 57	14 18	14 39	15 0	15 21	15 42	16 3	16 24	16 45	17 6
3·3	12·7	19·3	28·7	13 58	14 19	14 41	15 2	15 24	15 46	16 8	16 29	16 51	17 12	17 34
3·4	12·6	19·4	28·6	14 20	14 42	15 4	15 26	15 48	16 10	16 33	16 55	17 17	17 39	18 2
3·5	12·5	19·5	28·5	14 42	15 4	15 27	15 50	16 13	16 36	16 59	17 21	17 44	18 7	18 30
3·6	12·4	19·6	28·4	15 3	15 26	15 50	16 13	16 37	17 0	17 24	17 47	18 10	18 33	18 57
3·7	12·3	19·7	28·3	15 24	15 48	16 12	16 36	17 0	17 24	17 48	18 12	18 36	19 0	19 24
3·8	12·2	19·8	28·2	15 45	16 9	16 34	16 58	17 23	17 47	18 12	18 36	19 1	19 25	19 50
3·9	12·1	19·9	28·1	16 6	16 31	16 56	17 21	17 46	18 11	18 36	19 1	19 26	19 51	20 16
4·0	12·0	20·0	28·0	16 26	16 51	17 17	17 42	18 8	18 33	18 59	19 25	19 50	20 16	20 42
+	+	−	−											

for Azimuths referred to the Disturbed Compass.

Apparent Azimuth from Neutral Position in points and decimals.				Modulus. ·40	·41	·42	·43	·44	·45	·46	·47	·48	·49	·50
				Corresponding Polar-Magnet-Deviation, in degrees and minutes.										
+ p	+ p	− p	− p	° ′	° ′	° ′	° ′	° ′	° ′	° ′	° ′	° ′	° ′	° ′
4·0	12·0	20·0	28·0	16 26	16 51	17 17	17 42	18 8	18 33	18 59	19 25	19 50	20 16	20 42
4·1	11·9	20·1	27·9	16 46	17 12	17 38	18 4	18 30	18 56	19 22	19 48	20 14	20 40	21 7
4·2	11·8	20·2	27·8	17 5	17 32	17 58	18 25	18 51	19 18	19 45	20 11	20 38	21 5	21 32
4·3	11·7	20·3	27·7	17 24	17 51	18 18	18 45	19 12	19 40	20 7	20 34	21 2	21 29	21 57
4·4	11·6	20·4	27·6	17 42	18 10	18 37	19 5	19 33	20 1	20 29	20 57	21 25	21 53	22 21
4·5	11·5	20·5	27·5	18 0	18 29	18 57	19 25	19 53	20 22	20 50	21 18	21 47	22 15	22 44
4·6	11·4	20·6	27·4	18 18	18 47	19 15	19 44	20 13	20 42	21 11	21 40	22 9	22 38	23 7
4·7	11·3	20·7	27·3	18 36	19 5	19 34	20 3	20 32	21 2	21 31	22 0	22 30	22 59	23 29
4·8	11·2	20·8	27·2	18 53	19 23	19 52	20 22	20 51	21 21	21 51	22 21	22 51	23 21	23 51
4·9	11·1	20·9	27·1	19 10	19 40	20 10	20 40	21 10	21 40	22 10	22 40	23 11	23 42	24 13
5·0	11·0	21·0	27·0	19 26	19 56	20 26	20 57	21 27	21 58	22 29	23 0	23 31	24 2	24 34
5·1	10·9	21·1	26·9	19 41	20 12	20 43	21 14	21 45	22 16	22 48	23 19	23 51	24 22	24 54
5·2	10·8	21·2	26·8	19 56	20 28	20 59	21 31	22 2	22 34	23 6	23 38	24 10	24 42	25 14
5·3	10·7	21·3	26·7	20 11	20 43	21 15	21 47	22 19	22 51	23 23	23 55	24 28	25 0	25 33
5·4	10·6	21·4	26·6	20 26	20 58	21 30	22 2	22 34	23 7	23 40	24 13	24 46	25 19	25 52
5·5	10·5	21·5	26·5	20 40	21 12	21 44	22 17	22 50	23 23	23 56	24 29	25 3	25 36	26 10
5·6	10·4	21·6	26·4	20 53	21 26	21 59	22 32	23 5	23 38	24 12	24 45	25 19	25 53	26 27
5·7	10·3	21·7	26·3	21 6	21 39	22 12	22 46	23 19	23 53	24 27	25 1	25 35	26 9	26 44
5·8	10·2	21·8	26·2	21 18	21 52	22 25	22 59	23 33	24 7	24 42	25 16	25 51	26 25	27 0
5·9	10·1	21·9	26·1	21 30	22 4	22 38	23 12	23 46	24 21	24 56	25 31	26 6	26 41	27 16
6·0	10·0	22·0	26·0	21 41	22 16	22 50	23 25	23 59	24 34	25 9	25 44	26 20	26 55	27 31
6·1	9·9	22·1	25·9	21 52	22 27	23 1	23 36	24 11	24 46	25 22	25 57	26 33	27 9	27 45
6·2	9·8	22·2	25·8	22 2	22 37	23 12	23 47	24 22	24 58	25 34	26 10	26 46	27 22	27 59
6·3	9·7	22·3	25·7	22 12	22 48	23 23	23 58	24 33	25 9	25 46	26 22	26 59	27 35	28 12
6·4	9·6	22·4	25·6	22 22	22 58	23 33	24 9	24 44	25 20	25 57	26 33	27 10	27 47	28 24
6·5	9·5	22·5	25·5	22 31	23 7	23 42	24 18	24 54	25 30	26 7	26 44	27 21	27 58	28 35
6·6	9·4	22·6	25·4	22 39	23 15	23 51	24 27	25 3	25 40	26 17	26 54	27 31	28 8	28 46
6·7	9·3	22·7	25·3	22 46	23 23	23 59	24 36	25 12	25 49	26 26	27 3	27 41	28 18	28 56
6·8	9·2	22·8	25·2	22 53	23 30	24 6	24 43	25 20	25 57	26 35	27 12	27 50	28 27	29 5
6·9	9·1	22·9	25·1	23 0	23 37	24 13	24 50	25 27	26 4	26 42	27 20	27 58	28 36	29 14
7·0	9·0	23·0	25·0	23 6	23 43	24 20	24 57	25 34	26 11	26 49	27 27	28 5	28 43	29 22
7·1	8·9	23·1	24·9	23 11	23 48	24 25	25 2	25 39	26 17	26 56	27 34	28 12	28 50	29 29
7·2	8·8	23·2	24·8	23 16	23 53	24 30	25 8	25 45	26 23	27 2	27 40	28 19	28 57	29 36
7·3	8·7	23·3	24·7	23 20	23 58	24 35	25 13	25 50	26 28	27 7	27 45	28 24	29 2	29 41
7·4	8·6	23·4	24·6	23 24	24 2	24 39	25 17	25 55	26 32	27 11	27 49	28 28	29 7	29 46
7·5	8·5	23·5	24·5	23 27	24 5	24 42	25 20	25 58	26 36	27 15	27 53	28 32	29 11	29 50
7·6	8·4	23·6	24·4	23 30	24 8	24 45	25 23	26 1	26 39	27 18	27 57	28 36	29 15	29 54
7·7	8·3	23·7	24·3	23 32	24 10	24 48	25 26	26 3	26 41	27 20	27 59	28 38	29 17	29 56
7·8	8·2	23·8	24·2	23 34	24 11	24 49	25 27	26 5	26 43	27 22	28 1	28 40	29 19	29 58
7·9	8·1	23·9	24·1	23 35	24 12	24 50	25 28	26 6	26 44	27 23	28 2	28 41	29 20	29 59
8·0	8·0	24·0	24·0	23 35	24 13	24 51	25 29	26 7	26 45	27 24	28 3	28 42	29 21	30 0
+	+	−	−											
Mean				14 53	15 16	15 39	16 2	16 26	16 49	17 13	17 37	18 1	18 25	18 49

Table of Polar-Magnet-Deviations,

Apparent Azimuth from Neutral Position in points and decimals.				Modulus.										
				·50	·51	·52	·53	·54	·55	·56	·57	·58	·59	·60
				Corresponding Polar-Magnet-Deviation, in degrees and minutes.										
+	+	−	−											
p	p	p	p	° ′	° ′	° ′	° ′	° ′	° ′	° ′	° ′	° ′	° ′	° ′
0·0	16·0	16·0	32·0	0 0	0 0	0 0	0 0	0 0	0 0	0 0	0 0	0 0	0 0	0 0
0·1	15·9	16·1	31·9	0 34	0 34	0 35	0 36	0 36	0 37	0 38	0 38	0 39	0 40	0 41
0·2	15·8	16·2	31·8	1 7	1 8	1 10	1 11	1 13	1 14	1 16	1 17	1 18	1 19	1 21
0·3	15·7	16·3	31·7	1 41	1 43	1 45	1 47	1 49	1 52	1 54	1 56	1 58	2 0	2 2
0·4	15·6	16·4	31·6	2 15	2 17	2 20	2 22	2 25	2 28	2 31	2 33	2 36	2 39	2 42
0·5	15·5	16·5	31·5	2 49	2 52	2 55	2 58	3 2	3 5	3 9	3 12	3 16	3 19	3 23
0·6	15·4	16·6	31·4	3 22	2 26	3 30	3 34	3 38	3 42	3 47	3 51	3 55	3 59	4 3
0·7	15·3	16·7	31·3	3 56	4 0	4 5	4 9	4 14	4 19	4 24	4 28	4 33	4 38	4 43
0·8	15·2	16·8	31·2	4 29	4 34	4 40	4 45	4 51	4 56	5 2	5 7	5 12	5 17	5 23
0·9	15·1	16·9	31·1	5 3	5 9	5 15	5 21	5 27	5 33	5 39	5 45	5 51	5 57	6 3
1·0	15·0	17·0	31·0	5 36	5 42	5 49	5 55	6 2	6 9	6 16	6 22	6 29	6 36	6 43
1·1	14·9	17·1	30·9	6 9	6 16	6 24	6 31	6 39	6 46	6 54	7 1	7 8	7 15	7 23
1·2	14·8	17·2	30·8	6 42	6 50	6 58	7 6	7 14	7 22	7 31	7 39	7 47	7 55	8 3
1·3	14·7	17·3	30·7	7 15	7 23	7 32	7 41	7 50	7 59	8 8	8 16	8 25	8 34	8 43
1·4	14·6	17·4	30·6	7 48	7 57	8 7	8 16	8 26	8 35	8 45	8 54	9 3	9 12	9 22
1·5	14·5	17·5	30·5	8 21	8 31	8 41	8 51	9 1	9 11	9 22	9 32	9 42	9 52	10 2
1·6	14·4	17·6	30·4	8 53	9 4	9 15	9 25	9 36	9 47	9 58	10 8	10 19	10 30	10 41
1·7	14·3	17·7	30·3	9 25	9 36	9 48	9 59	10 11	10 22	10 34	10 45	10 57	11 8	11 20
1·8	14·2	17·8	30·2	9 58	10 10	10 22	10 34	10 46	10 58	11 11	11 23	11 35	11 47	11 59
1·9	14·1	17·9	30·1	10 30	10 43	10 56	11 8	11 21	11 34	11 47	11 59	12 12	12 25	12 38
2·0	14·0	18·0	30·0	11 2	11 15	11 29	11 42	11 56	12 9	12 23	12 36	12 49	13 2	13 16
2·1	13·9	18·1	29·9	11 34	11 48	12 2	12 16	12 30	12 44	12 58	13 12	13 26	13 40	13 54
2·2	13·8	18·2	29·8	12 5	12 20	12 35	12 49	13 4	13 19	13 34	13 48	14 3	14 18	14 33
2·3	13·7	18·3	29·7	12 36	12 51	13 7	13 22	13 38	13 53	14 9	14 25	14 40	14 55	15 11
2·4	13·6	18·4	29·6	13 7	13 23	13 39	13 55	14 11	14 27	14 44	15 0	15 16	15 32	15 48
2·5	13·5	18·5	29·5	13 38	13 54	14 11	14 27	14 44	15 1	15 18	15 35	15 51	16 8	16 25
2·6	13·4	18·6	29·4	14 8	14 25	14 43	15 0	15 18	15 35	15 53	16 10	16 28	16 45	17 3
2·7	13·3	18·7	29·3	14 38	14 56	15 14	15 32	15 50	16 8	16 27	16 45	17 3	17 21	17 40
2·8	13·2	18·8	29·2	15 8	15 26	15 45	16 4	16 23	16 42	17 1	17 19	17 38	17 57	18 16
2·9	13·1	18·9	29·1	15 38	15 57	16 17	16 36	16 56	17 15	17 35	17 54	18 13	18 32	18 52
3·0	13·0	19·0	29·0	16 8	16 28	16 48	17 8	17 28	17 48	18 8	18 28	18 48	19 8	19 28
3·1	12·9	19·1	28·9	16 37	16 58	17 18	17 38	17 59	18 20	18 41	19 1	19 22	19 43	20 4
3·2	12·8	19·2	28·8	17 6	17 27	17 48	18 9	18 31	18 52	19 14	19 35	19 56	20 17	20 39
3·3	12·7	19·3	28·7	17 34	17 56	18 18	18 40	19 2	19 24	19 46	20 8	20 30	20 52	21 14
3·4	12·6	19·4	28·6	18 2	18 24	18 47	19 9	19 32	19 55	20 18	20 40	21 3	21 25	21 48
3·5	12·5	19·5	28·5	18 30	18 53	19 16	19 39	20 2	20 26	20 49	21 12	21 35	21 58	22 22
3·6	12·4	19·6	28·4	18 57	19 21	19 45	20 9	20 33	20 57	21 21	21 44	22 8	22 32	22 56
3·7	12·3	19·7	28·3	19 24	19 48	20 13	20 37	21 2	21 26	21 51	22 15	22 40	23 4	23 29
3·8	12·2	19·8	28·2	19 50	20 15	20 41	21 6	21 31	21 56	22 22	22 47	23 12	23 37	24 2
3·9	12·1	19·9	28·1	20 16	20 42	21 8	21 34	21 59	22 25	22 51	23 17	23 43	24 8	24 34
4·0	12·0	20·0	28·0	20 42	21 8	21 34	22 1	22 27	22 53	23 20	23 46	24 13	24 39	25 6
+	+	−	−											

for Azimuths referred to the Disturbed Compass.

Apparent Azimuth from Neutral Position in points and decimals.				Modulus.										
				·50	·51	·52	·53	·54	·55	·56	·57	·58	·59	·60
				Corresponding Polar-Magnet-Deviation, in degrees and minutes.										
+ p	+ p	− p	− p	° ′	° ′	° ′	° ′	° ′	° ′	° ′	° ′	° ′	° ′	° ′
4·0	12·0	20·0	28·0	20 42	21 8	21 34	22 1	22 27	22 53	23 20	23 46	24 13	24 39	25 6
4·1	11·9	20·1	27·9	21 7	21 34	22 1	22 27	22 54	23 21	23 49	24 16	24 43	25 10	25 37
4·2	11·8	20·2	27·8	21 32	21 59	22 27	22 54	23 22	23 49	24 17	24 44	25 12	25 40	26 8
4·3	11·7	20·3	27·7	21 57	22 25	22 53	23 20	23 48	24 16	24 45	25 13	25 42	26 10	26 39
4·4	11·6	20·4	27·6	22 21	22 49	23 18	23 46	24 14	24 43	25 12	25 41	26 10	26 39	27 9
4·5	11·5	20·5	27·5	22 44	23 13	23 42	24 11	24 40	25 9	25 39	26 8	26 38	27 8	27 38
4·6	11·4	20·6	27·4	23 7	23 36	24 6	24 35	25 5	25 35	26 5	26 35	27 6	27 36	28 7
4·7	11·3	20·7	27·3	23 29	23 59	24 30	25 0	25 30	26 0	26 31	27 2	27 33	28 4	28 35
4·8	11·2	20·8	27·2	23 51	24 22	24 53	25 24	25 54	26 25	26 56	27 27	27 59	28 30	29 2
4·9	11·1	20·9	27·1	24 13	24 44	25 16	25 47	26 18	26 49	27 21	27 53	28 25	28 57	29 29
5·0	11·0	21·0	27·0	24 34	25 6	25 38	26 9	26 41	27 13	27 46	28 18	28 51	29 23	29 56
5·1	10·9	21·1	26·9	24 54	25 26	25 59	26 31	27 3	27 36	28 9	28 42	29 15	29 48	30 22
5·2	10·8	21·2	26·8	25 14	25 47	26 20	26 52	27 25	27 58	28 32	29 5	29 39	30 12	30 46
5·3	10·7	21·3	26·7	25 33	26 6	26 40	27 13	27 46	28 20	28 54	29 28	30 2	30 36	31 10
5·4	10·6	21·4	26·6	25 52	26 26	27 0	27 33	28 7	28 41	29 16	29 50	30 25	30 59	31 34
5·5	10·5	21·5	26·5	26 10	26 44	27 19	27 53	28 27	29 1	29 37	30 12	30 47	31 22	31 57
5·6	10·4	21·6	26·4	26 27	27 2	27 37	28 11	28 46	29 21	29 57	30 32	31 8	31 43	32 19
5·7	10·3	21·7	26·3	26 44	27 19	27 54	28 29	29 4	29 40	30 16	30 52	31 28	32 4	32 40
5·8	10·2	21·8	26·2	27 0	27 35	28 11	28 46	29 22	29 58	30 35	31 11	31 48	32 24	33 1
5·9	10·1	21·9	26·1	27 16	27 51	28 27	29 3	29 39	30 15	30 53	31 30	32 7	32 44	33 21
6·0	10·0	22·0	26·0	27 31	28 7	28 43	29 19	29 55	30 32	31 10	31 47	32 25	33 2	33 40
6·1	9·9	22·1	25·9	27 45	28 21	28 58	29 34	30 11	30 48	31 26	32 4	32 42	33 20	33 58
6·2	9·8	22·2	25·8	27 59	28 36	29 13	29 49	30 26	31 3	31 41	32 19	32 58	33 36	34 15
6·3	9·7	22·3	25·7	28 12	28 49	29 26	30 3	30 40	31 18	31 56	32 35	33 14	33 53	34 32
6·4	9·6	22·4	25·6	28 24	29 2	29 39	30 16	30 54	31 32	32 11	32 50	33 29	34 8	34 48
6·5	9·5	22·5	25·5	28 35	29 13	29 51	30 29	31 7	31 45	32 25	33 4	33 44	34 23	35 3
6·6	9·4	22·6	25·4	28 46	29 24	30 3	30 41	31 19	31 58	32 38	33 17	33 57	34 36	35 16
6·7	9·3	22·7	25·3	28 56	29 34	30 13	30 51	31 30	32 10	32 50	33 29	34 9	34 49	35 29
6·8	9·2	22·8	25·2	29 5	29 43	30 22	31 1	31 41	32 20	33 0	33 40	34 20	35 0	35 41
6·9	9·1	22·9	25·1	29 14	20 52	30 31	31 11	31 51	32 30	33 10	33 50	34 31	35 11	35 52
7·0	9·0	23·0	25·0	29 22	30 0	30 39	31 19	31 59	32 39	33 19	34 0	34 41	35 22	36 3
7·1	8·9	23·1	24·9	29 29	30 8	30 47	31 27	32 7	32 47	33 27	54 8	34 50	35 31	36 13
7·2	8·8	23·2	24·8	29 36	30 15	30 54	31 34	32 14	32 54	33 35	34 16	34 58	35 39	36 21
7·3	8·7	23·3	24·7	29 41	30 20	31 0	31 40	32 20	33 0	33 42	34 23	35 5	35 46	36 28
7·4	8·6	23·4	24·6	29 46	30 25	31 5	31 45	32 26	33 6	33 47	34 28	35 10	35 52	36 34
7·5	8·5	23·5	24·5	29 50	30 29	31 9	31 50	32 31	33 11	33 52	34 33	35 15	35 57	36 39
7·6	8·4	23·6	24·4	29 54	30 33	31 13	31 53	32 34	33 15	33 56	34 38	35 20	36 2	36 44
7·7	8·3	23·7	24·3	29 56	30 36	31 16	31 56	32 37	33 18	33 59	34 41	35 23	36 5	36 48
7·8	8·2	23·8	24·2	29 58	30 38	31 18	31 58	32 39	33 20	34 1	34 43	35 25	36 8	36 50
7·9	8·1	23·9	24·1	29 59	30 39	31 20	32 0	32 41	33 21	34 2	34 44	35 26	36 9	36 52
8·0	8·0	24·0	24·0	30 0	30 40	31 21	32 1	32 42	33 22	34 3	34 45	35 27	36 9	36 52
+	+	−	−											
Mean				18 49	19 13	19 37	20 1	20 26	20 51	21 15	21 40	22 5	22 30	22 55

Table of Polar-Magnet-Deviations,

Apparent Azimuth from Neutral Position in points and decimals.				Modulus.										
				·60	·61	·62	·63	·64	·65	·66	·67	·68	·69	·70
				Corresponding Polar-Magnet-Deviation, in degrees and minutes.										
+ p	+ p	− p	− p	° ′	° ′	° ′	° ′	° ′	° ′	° ′	° ′	° ′	° ′	° ′
0·0	16·0	16·0	32·0	0 0	0 0	0 0	0 0	0 0	0 0	0 0	0 0	0 0	0 0	0 0
0·1	15·9	16·1	31·9	0 41	0 41	0 42	0 42	0 43	0 44	0 45	0 45	0 46	0 46	0 47
0·2	15·8	16·2	31·8	1 21	1 22	1 24	1 25	1 26	1 27	1 29	1 30	1 31	1 32	1 34
0·3	15·7	16·3	31·7	2 2	2 4	2 6	2 8	2 10	2 12	2 14	2 15	2 17	2 19	2 21
0·4	15·6	16·4	31·6	2 42	2 44	2 47	2 49	2 52	2 55	2 58	3 0	3 3	3 5	3 8
0·5	15·5	16·5	31·5	3 23	3 26	3 29	3 32	3 36	3 39	3 43	3 46	3 49	3 52	3 56
0·6	15·4	16·6	31·4	4 3	4 7	4 11	4 15	4 19	4 23	4 27	4 31	4 35	4 39	4 43
0·7	15·3	16·7	31·3	4 43	4 48	4 53	4 57	5 2	5 7	5 12	5 16	5 21	5 25	5 30
0·8	15·2	16·8	31·2	5 23	5 28	5 34	5 39	5 45	5 50	5 56	6 1	6 6	6 11	6 17
0·9	15·1	16·9	31·1	6 3	6 9	6 15	6 21	6 27	6 33	6 40	6 46	6 52	6 58	7 4
1·0	15·0	17·0	31·0	6 43	6 50	6 57	7 3	7 10	7 17	7 24	7 30	7 37	7 44	7 51
1·1	14·9	17·1	30·9	7 23	7 30	7 38	7 45	7 53	8 0	8 8	8 15	8 23	8 30	8 38
1·2	14·8	17·2	30·8	8 3	8 11	8 19	8 27	8 35	8 43	8 52	9 0	9 8	9 16	9 24
1·3	14·7	17·3	30·7	8 43	8 51	9 0	9 8	9 17	9 26	9 35	9 43	9 52	10 1	10 10
1·4	14·6	17·4	30·6	9 22	9 31	9 41	9 50	10 0	10 9	10 19	10 28	10 38	10 47	10 57
1·5	14·5	17·5	30·5	10 2	10 12	10 22	10 32	10 42	10 53	11 3	11 13	11 23	11 33	11 43
1·6	14·4	17·6	30·4	10 41	10 52	11 3	11 13	11 24	11 35	11 46	11 56	12 7	12 18	12 29
1·7	14·3	17·7	30·3	11 20	11 31	11 43	11 54	12 6	12 17	12 29	12 40	12 52	13 3	13 15
1·8	14·2	17·8	30·2	11 59	12 11	12 23	12 35	12 47	12 59	13 12	13 24	13 36	13 48	14 1
1·9	14·1	17·9	30·1	12 38	12 50	13 3	13 16	13 29	13 42	13 55	14 8	14 21	14 34	14 47
2·0	14·0	18·0	30·0	13 16	13 29	13 43	13 56	14 10	14 24	14 38	14 51	15 5	15 18	15 32
2·1	13·9	18·1	29·9	13 54	14 8	14 23	14 37	14 51	15 5	15 20	15 34	15 49	16 3	16 17
2·2	13·8	18·2	29·8	14 33	14 48	15 3	15 18	15 33	15 48	16 3	16 17	16 32	16 47	17 2
2·3	13·7	18·3	29·7	15 11	15 26	15 42	15 57	16 13	16 29	16 45	17 0	17 16	17 31	17 47
2·4	13·6	18·4	29·6	15 48	16 4	16 21	16 37	16 53	17 9	17 26	17 42	17 58	18 14	18 31
2·5	13·5	18·5	29·5	16 25	16 42	17 0	17 17	17 34	17 51	18 8	18 25	18 42	18 59	19 16
2·6	13·4	18·6	29·4	17 3	17 20	17 38	17 55	18 13	18 31	18 49	19 6	19 24	19 42	20 0
2·7	13·3	18·7	29·3	17 40	17 58	18 16	18 34	18 53	19 11	19 30	19 48	20 7	20 25	20 44
2·8	13·2	18·8	29·2	18 16	18 35	18 54	19 13	19 32	19 51	20 11	20 30	20 49	21 8	21 27
2·9	13·1	18·9	29·1	18 52	19 12	19 32	19 51	20 11	20 31	20 51	21 10	21 30	21 50	22 10
3·0	13·0	19·0	29·0	19 28	19 48	20 9	20 29	20 50	21 10	21 31	21 51	22 12	22 32	22 53
3·1	12·9	19·1	28·9	20 4	21 25	20 46	21 7	21 28	21 49	22 11	22 32	22 53	23 14	23 36
3·2	12·8	19·2	28·8	20 39	21 0	21 22	21 44	22 6	22 28	22 50	23 12	23 34	23 56	24 18
3·3	12·7	19·3	28·7	21 14	21 36	21 58	22 20	22 43	23 6	23 29	23 51	24 14	24 37	25 0
3·4	12·6	19·4	28·6	21 48	22 11	22 34	22 57	23 21	23 44	24 8	24 31	24 54	25 17	25 41
3·5	12·5	19·5	28·5	22 22	22 45	23 9	23 33	23 57	24 21	24 46	25 10	25 34	25 58	26 22
3·6	12·4	19·6	28·4	22 56	23 20	23 44	24 9	24 34	24 59	25 24	25 48	26 13	26 38	27 3
3·7	12·3	19·7	28·3	23 29	23 54	24 19	24 44	25 10	25 35	26 1	26 26	26 52	27 17	27 43
3·8	12·2	19·8	28·2	24 2	24 27	24 53	25 19	25 45	26 11	26 38	27 4	27 30	27 56	28 22
3·9	12·1	19·9	28·1	24 34	25 0	25 27	25 53	26 20	26 47	27 14	27 40	28 7	28 34	29 1
4·0	12·0	20·0	28·0	25 6	25 33	26 0	26 28	26 55	27 22	27 50	28 17	28 45	29 12	29 40
+	+	−	−											

for Azimuths referred to the Disturbed Compass.

Apparent Azimuth from Neutral Position in points and decimals.				Modulus. ·60	·61	·62	·63	·64	·65	·66	·67	·68	·69	·70
				Corresponding Polar-Magnet-Deviation, in degrees and minutes.										
+ p	+ p	− p	− p	° ′	° ′	° ′	° ′	° ′	° ′	° ′	° ′	° ′	° ′	° ′
4·0	12·0	20·0	28·0	25 6	25 33	26 0	26 28	26 55	27 22	27 50	28 17	28 45	29 12	29 40
4·1	11·9	20·1	27·9	25 37	26 5	26 33	27 1	27 29	27 56	28 24	28 53	29 22	29 50	30 18
4·2	11·8	20·2	27·8	26 8	26 36	27 5	27 33	28 2	28 30	28 59	29 28	29 58	30 27	30 56
4·3	11·7	20·3	27·7	26 39	27 8	27 37	28 6	28 35	29 4	29 34	30 4	30 34	31 3	31 33
4·4	11·6	20·4	27·6	27 9	27 38	28 8	28 38	29 8	29 37	30 8	30 38	31 9	31 39	32 10
4·5	11·5	20·5	27·5	27 38	28 8	28 38	29 9	29 40	30 10	30 41	31 12	31 43	32 14	32 46
4·6	11·4	20·6	27·4	28 7	28 38	29 9	29 40	30 11	30 42	31 13	31 45	32 17	32 49	33 21
4·7	11·3	20·7	27·3	28 35	29 6	29 38	30 9	30 41	31 13	31 45	32 17	32 50	33 23	33 56
4·8	11·2	20·8	27·2	29 2	29 34	30 6	30 38	31 11	31 44	32 17	32 50	33 23	33 56	34 30
4·9	11·1	20·9	27·1	29 29	30 1	30 34	31 7	31 40	32 14	32 48	33 21	33 55	34 29	35 3
5·0	11·0	21·0	27·0	29 56	30 29	31 2	31 35	32 9	32 43	33 18	33 52	34 26	35 1	35 36
5·1	10·9	21·1	26·9	30 22	30 55	31 29	32 3	32 37	33 11	33 46	34 21	34 56	35 32	36 8
5·2	10·8	21·2	26·8	30 46	31 20	31 55	32 29	33 4	33 39	34 14	34 50	35 26	36 2	36 39
5·3	10·7	21·3	26·7	31 10	31 45	32 20	32 55	33 30	34 6	34 42	35 18	35 55	36 32	37 9
5·4	10·6	21·4	26·6	31 34	32 9	32 45	33 20	33 56	34 32	35 9	35 46	36 24	37 2	37 39
5·5	10·5	21·5	26·5	31 57	32 33	33 9	33 45	34 21	34 58	35 36	36 14	36 52	37 30	38 8
5·6	10·4	21·6	26·4	32 19	32 55	33 32	34 9	34 46	35 23	36 1	36 39	37 18	37 56	38 35
5·7	10·3	21·7	26·3	32 40	33 17	33 55	34 32	35 10	35 47	36 25	37 4	37 43	38 22	39 2
5·8	10·2	21·8	26·2	33 1	33 38	34 16	34 54	35 32	36 10	36 48	37 28	38 8	38 48	39 28
5·9	10·1	21·9	26·1	33 21	33 59	34 37	35 15	35 54	36 32	37 11	37 51	38 32	39 12	39 53
6·0	10·0	22·0	26·0	33 40	34 18	34 57	35 36	36 15	36 54	37 33	38 14	38 55	39 36	40 18
6·1	9·9	22·1	25·9	33 58	34 37	35 16	35 55	36 35	37 14	37 54	38 35	39 17	39 59	40 41
6·2	9·8	22·2	25·8	34 15	34 54	35 34	36 14	36 54	37 34	38 14	38 56	39 39	40 21	41 3
6·3	9·7	22·3	25·7	34 32	35 12	35 52	36 32	37 12	37 53	38 34	39 16	39 59	40 41	41 24
6·4	9·6	22·4	25·6	34 48	35 28	36 9	36 49	37 30	38 11	38 53	39 35	40 17	41 0	41 44
6·5	9·5	22·5	25·5	35 3	35 43	36 24	37 5	37 46	38 28	39 10	39 52	40 35	41 19	42 3
6·6	9·4	22·6	25·4	35 16	35 57	36 38	37 19	38 1	38 44	39 26	40 9	40 52	41 36	42 21
6·7	9·3	22·7	25·3	35 29	36 10	36 52	37 33	38 15	38 59	39 42	40 25	41 9	41 53	42 38
6·8	9·2	22·8	25·2	35 41	36 23	37 5	37 47	38 29	39 12	39 56	40 40	41 24	42 9	42 54
6·9	9·1	22·9	25·1	35 52	36 34	37 16	37 58	38 41	39 24	40 8	40 53	41 37	42 22	43 8
7·0	9·0	23·0	25·0	36 3	36 45	37 27	38 9	38 52	39 36	40 20	41 4	41 49	42 35	43 21
7·1	8·9	23·1	24·9	36 13	36 55	37 37	38 19	39 2	39 46	40 30	41 15	42 0	42 46	43 33
7·2	8·8	23·2	24·8	36 21	37 3	37 46	38 29	39 12	39 56	40 40	41 25	42 11	42 57	43 44
7·3	8·7	23·3	24·7	36 28	37 11	37 54	38 37	39 21	40 5	40 49	41 35	42 21	43 7	43 54
7·4	8·6	23·4	24·6	36 34	37 17	38 1	38 44	39 28	40 12	40 57	41 42	42 28	43 15	44 2
7·5	8·5	23·5	24·5	36 39	37 22	38 6	38 50	39 34	40 18	41 3	41 49	42 35	43 22	44 9
7·6	8·4	23·6	24·4	36 44	37 27	38 11	38 55	39 39	40 23	41 8	41 54	42 41	43 28	44 15
7·7	8·3	23·7	24·3	36 48	37 31	38 15	38 59	39 43	40 27	41 12	41 58	42 45	43 32	44 20
7·8	8·2	23·8	24·2	36 50	37 33	38 17	39 1	39 45	40 29	41 15	42 1	42 48	43 35	44 23
7·9	8·1	23·9	24·1	36 52	37 35	38 19	39 2	39 46	40 31	41 17	42 3	42 50	43 37	44 25
8·0 +	8·0 +	24·0 −	24·0 −	36 52	37 35	38 19	39 3	39 47	40 32	41 18	42 4	42 51	43 38	44 26
Mean				22 55	23 20	23 46	24 12	24 38	25 4	25 30	25 56	26 23	26 50	27 17

Table of Polar-Magnet-Deviations,

Apparent Azimuth from Neutral Position n points and decimals.				Modulus.										
				·70	·71	·72	·73	·74	·75	·76	·77	·78	·79	·80
				Corresponding Polar-Magnet-Deviation, in degrees and minutes.										
+	+	−	−											
p	p	p	p	° ′	° ′	° ′	° ′	° ′	° ′	° ′	° ′	° ′	° ′	° ′
0·0	16·0	16·0	32·0	0 0	0 0	0 0	0 0	0 0	0 0	0 0	0 0	0 0	0 0	0 0
0·1	15·9	16·1	31·9	0 47	0 47	0 48	0 48	0 49	0 50	0 51	0 51	0 52	0 53	0 54
0·2	15·8	16·2	31·8	1 34	1 35	1 37	1 38	1 40	1 41	1 43	1 44	1 45	1 46	1 48
0·3	15·7	16·3	31·7	2 21	2 23	2 25	2 27	2 29	2 31	2 34	2 36	2 38	2 40	2 42
0·4	15·6	16·4	31·6	3 8	3 11	3 14	3 16	3 19	3 22	3 25	3 27	3 30	3 33	3 36
0·5	15·5	16·5	31·5	3 56	3 59	4 2	4 5	4 9	4 12	4 16	4 19	4 23	4 26	4 30
0·6	15·4	16·6	31·4	4 43	4 47	4 51	4 55	4 59	5 3	5 8	5 12	5 16	5 20	5 24
0·7	15·3	16·7	31·3	5 30	5 34	5 39	5 44	5 49	5 54	5 59	6 3	6 8	6 13	6 18
0·8	15·2	16·8	31·2	6 17	6 22	6 28	6 33	6 39	6 44	6 50	6 55	7 1	7 6	7 12
0·9	15·1	16·9	31·1	7 4	7 1	7 16	7 22	7 28	7 34	7 41	7 47	7 53	7 59	8 6
1·0	15·0	17·0	31·0	7 51	7 57	8 4	8 11	8 18	8 25	8 32	8 38	8 45	8 52	8 59
1·1	14·9	17·1	30·9	8 38	8 45	8 52	8 59	9 7	9 15	9 23	9 30	9 38	9 45	9 53
1·2	14·8	17·2	30·8	9 24	9 32	9 40	9 48	9 56	10 4	10 13	10 21	10 29	10 37	10 46
1·3	14·7	17·3	30·7	10 10	10 19	10 28	10 37	10 46	10 55	11 4	11 13	11 22	11 31	11 40
1·4	14·6	17·4	30·6	10 57	11 6	11 16	11 25	11 35	11 45	11 55	12 4	12 14	12 23	12 33
1·5	14·5	17·5	30·5	11 43	11 53	12 4	12 14	12 24	12 34	12 45	12 55	13 5	13 15	13 26
1·6	14·4	17·6	30·4	12 29	12 41	12 51	13 2	13 13	13 24	13 35	13 46	13 57	14 8	14 19
1·7	14·3	17·7	30·3	13 15	13 27	13 39	13 50	14 2	14 14	14 26	14 37	14 49	15 0	15 12
1·8	14·2	17·8	30·2	14 1	14 13	14 26	14 38	14 50	15 2	15 15	15 27	15 39	15 52	16 4
1·9	14·1	17·9	30·1	14 47	15 0	15 13	15 26	15 39	15 52	16 5	16 18	16 31	16 44	16 57
2·0	14·0	18·0	30·0	15 32	15 45	15 59	16 12	16 26	16 40	16 54	17 8	17 22	17 35	17 49
2·1	13·9	18·1	29·9	16 17	16 31	16 46	17 0	17 15	17 29	17 44	17 58	18 13	18 27	18 42
2·2	13·8	18·2	29·8	17 2	17 17	17 32	17 47	18 2	18 17	18 33	18 48	19 3	19 18	19 34
2·3	13·7	18·3	29·7	17 47	18 2	18 18	18 34	18 50	19 6	19 22	19 38	19 54	20 10	20 26
2·4	13·6	18·4	29·6	18 31	18 47	19 4	19 20	19 37	19 54	20 11	20 27	20 44	21 1	21 18
2·5	13·5	18·5	29·5	19 16	19 33	19 50	20 7	20 25	20 42	21 0	21 17	21 35	21 52	22 10
2·6	13·4	18·6	29·4	20 0	20 18	20 36	20 54	21 12	21 30	21 49	22 7	22 25	22 43	23 1
2·7	13·3	18·7	29·3	20 44	21 2	21 21	21 40	21 59	22 18	22 37	22 55	23 14	23 33	23 52
2·8	13·2	18·8	29·2	21 27	21 46	22 6	22 25	22 45	23 5	23 25	23 44	24 4	24 23	24 43
2·9	13·1	18·9	29·1	22 10	22 30	22 51	23 11	23 31	23 51	24 12	24 32	24 52	25 12	25 33
3·0	13·0	19·0	29·0	22 53	23 14	23 35	23 56	24 17	24 38	24 59	25 20	25 41	26 2	26 23
3·1	12·9	19·1	28·9	23 36	23 57	24 19	24 40	25 2	25 24	25 46	26 7	26 29	26 51	27 13
3·2	12·8	19·2	28·8	24 18	24 40	25 2	25 24	25 47	26 9	26 32	26 54	27 17	27 39	28 2
3·3	12·7	19·3	28·7	25 0	25 22	25 45	26 8	26 32	26 55	27 19	27 42	28 5	28 28	28 52
3·4	12·6	19·4	28·6	25 41	26 4	26 28	26 52	27 16	27 40	28 5	28 29	28 53	29 17	29 41
3·5	12·5	19·5	28·5	26 22	26 46	27 10	27 35	28 0	28 25	28 50	29 15	29 40	30 5	30 30
3·6	12·4	19·6	28·4	27 3	27 27	27 52	28 17	28 43	29 9	29 35	30 0	30 26	30 52	31 18
3·7	12·3	19·7	28·3	27 43	28 8	28 34	29 0	29 27	29 53	30 20	30 46	31 13	31 39	32 6
3·8	12·2	19·8	28·2	28 22	28 48	29 15	29 42	30 9	30 36	31 4	31 31	31 58	32 25	32 53
3·9	12·1	19·9	28·1	29 1	29 28	29 56	30 24	30 52	31 20	31 48	32 16	32 44	33 12	33 40
4·0	12·0	20·0	28·0	29 40	30 8	30 37	31 5	31 34	32 2	32 31	33 0	33 29	33 58	34 27
+	+	−	−											

for Azimuths referred to the Disturbed Compass.

Apparent Azimuth from Neutral Position in points and decimals.				Modulus.										
				·70	·71	·72	·73	·74	·75	·76	·77	·78	·79	·80
				Corresponding Polar-Magnet-Deviation, in degrees and minutes.										
+ p	+ p	− p	− p	° ′	° ′	° ′	° ′	° ′	° ′	° ′	° ′	° ′	° ′	° ′
4·0	12·0	20·0	28·0	29 40	30 8	30 37	31 5	31 34	32 2	32 31	33 0	33 29	33 58	34 27
4·1	11·9	20·1	27·9	30 18	30 47	31 17	31 46	32 15	32 44	33 14	33 43	34 13	34 43	35 13
4·2	11·8	20·2	27·8	30 56	31 26	31 56	32 26	32 56	33 25	33 56	34 26	34 57	35 28	35 59
4·3	11·7	20·3	27·7	31 33	32 3	32 34	33 5	33 36	34 6	34 37	35 8	35 40	36 12	36 44
4·4	11·6	20·4	27·6	32 10	32 41	33 12	33 43	34 15	34 46	35 18	35 50	36 23	36 55	37 28
4·5	11·5	20·5	27·5	32 46	33 17	33 49	34 21	34 54	35 26	35 59	36 32	37 5	37 38	38 12
4·6	11·4	20·6	27·4	33 21	33 53	34 26	34 59	35 32	36 5	36 39	37 13	37 47	38 21	38 55
4·7	11·3	20·7	27·3	33 56	34 29	35 2	35 36	36 10	36 43	37 18	37 53	38 28	39 3	39 38
4·8	11·2	20·8	27·2	34 30	35 4	35 38	36 12	36 47	37 21	37 57	38 32	39 8	39 44	40 20
4·9	11·1	20·9	27·1	35 3	35 38	36 13	36 48	37 23	37 58	38 35	39 11	39 47	40 24	41 1
5·0	11·0	21·0	27·0	35 36	36 11	36 47	37 23	37 59	38 35	39 12	39 49	40 26	41 4	41 42
5·1	10·9	21·1	26·9	36 8	36 44	37 20	37 57	38 34	39 10	39 48	40 26	41 4	41 43	42 22
5·2	10·8	21·2	26·8	36 39	37 16	37 53	38 30	39 8	39 45	40 24	41 3	41 42	42 21	43 1
5·3	10·7	21·3	26·7	37 9	37 47	38 25	39 3	39 41	40 19	40 59	41 39	42 19	42 59	43 39
5·4	10·6	21·4	26·6	37 39	38 17	38 56	39 35	40 14	40 53	41 34	42 14	42 54	43 35	44 16
5·5	10·5	21·5	26·5	38 8	38 47	39 26	40 5	40 45	41 25	42 7	42 47	43 28	44 10	44 52
5·6	10·4	21·6	26·4	38 35	39 15	39 55	40 35	41 16	41 56	42 38	43 20	44 2	44 45	45 28
5·7	10·3	21·7	26·3	39 2	39 42	40 23	41 4	41 45	42 26	43 9	43 52	44 35	45 19	46 3
5·8	10·2	21·8	26·2	39 28	40 9	40 50	41 32	42 14	42 56	43 39	44 23	45 6	45 51	46 36
5·9	10·1	21·9	26·1	39 53	40 34	41 16	41 59	42 42	43 25	44 8	44 52	45 36	46 22	47 8
6·0	10·0	22·0	26·0	40 18	41 0	41 42	42 25	43 8	43 52	44 36	45 21	46 6	46 52	47 39
6·1	9·9	22·1	25·9	40 41	41 24	42 7	42 50	43 34	44 18	45 3	45 49	46 35	47 22	48 9
6·2	9·8	22·2	25·8	41 3	41 46	42 29	43 13	43 58	44 43	45 28	46 15	47 2	47 50	48 38
6·3	9·7	22·3	25·7	41 24	42 7	42 51	43 36	44 21	45 7	45 53	46 40	47 28	48 17	49 6
6·4	9·6	22·4	25·6	41 44	42 28	43 12	43 57	44 43	45 30	46 17	47 5	47 53	48 42	49 32
6·5	9·5	22·5	25·5	42 3	42 47	43 32	44 18	45 4	45 51	46 39	47 28	48 17	49 7	49 57
6·6	9·4	22·6	25·4	42 21	43 6	43 51	44 37	45 24	46 12	47 0	47 49	48 39	49 30	50 21
6·7	9·3	22·7	25·3	42 38	43 23	44 9	44 56	45 43	46 31	47 20	48 10	49 0	49 51	50 43
6·8	9·2	22·8	25·2	42 54	43 40	44 26	45 13	46 1	46 49	47 39	48 29	49 20	50 12	51 4
6·9	9·1	22·9	25·1	43 8	43 54	44 41	45 29	46 17	47 6	47 56	48 47	49 38	50 30	51 23
7·0	9·0	23·0	25·0	43 21	44 8	44 55	45 43	46 32	47 21	48 12	49 3	49 55	50 48	51 41
7·1	8·9	23·1	24·9	43 33	44 20	45 8	45 56	46 45	47 35	48 26	49 18	50 10	51 3	51 57
7·2	8·8	23·2	24·8	43 44	44 31	45 19	46 8	46 57	47 48	48 39	49 31	50 24	51 18	52 12
7·3	8·7	23·3	24·7	43 54	44 41	45 29	46 18	47 8	47 59	48 51	49 43	50 36	51 30	52 25
7·4	8·6	23·4	24·6	44 2	44 50	45 38	46 27	47 17	48 8	49 0	49 53	50 46	51 41	52 36
7·5	8·5	23·5	24·5	44 9	44 57	45 46	46 35	47 25	48 16	49 8	50 1	50 55	51 50	52 46
7·6	8·4	23·6	24·4	44 15	45 3	45 52	46 42	47 32	48 23	49 15	50 8	51 2	51 58	52 54
7·7	8·3	23·7	24·3	44 20	45 8	45 57	46 47	47 37	48 28	49 21	50 14	51 8	52 4	53 0
7·8	8·2	23·8	24·2	44 23	45 11	46 0	46 50	47 40	48 32	49 25	50 19	51 13	52 8	53 4
7·9	8·1	23·9	24·1	44 25	45 13	46 2	46 52	47 42	48 34	49 27	50 21	51 15	52 10	53 7
8·0	8·0	24·0	24·0	44 26	45 14	46 3	46 53	47 44	48 35	49 28	50 21	51 16	52 11	53 8
+	+	−	−											
Mean				27 17	27 44	28 11	28 39	29 7	29 35	30 4	30 33	31 2	31 32	32 2